NOVEMBER, 1933.

GENERAL PHYSICS.

ADSORPTION.

4709. Adsorption and Capillary Condensation. M. Polanyi. *Phys. Zeits. d. Sowjetunion*, 4. 2. *pp.* 144–154 ; *Disc.*, 154–155, 1933.—The question of the mechanism of the condensation of vapours in the pores of adsorbent charcoal is discussed. From the experimental data, the conclusion is deduced that the condensation of gases and vapours on porous substances is to be regarded mainly, not as capillary condensation, but as true adsorption. The potential theory in its present form appears to furnish the most approximate means of explaining the phenomena. The swelling of carbon during adsorption is considered. T. H. P.

4710. Capillary Condensation of Vapours on Porous Sorbents. M. Dubinin. *Phys. Zeits. d. Sowjetunion*, 4. 2. *pp.* 156–171, 1933.—Two views are held concerning the sorption phenomena of vapours at porous sorbents. Polanyi regards such sorption as a condensation at the whole surface of the sorbent under the influence of adsorption forces. On the other hand, Zsigmondy and his school consider it to be a space-condensation of the vapour which is determined, not by the surface of sorbent, but by the magnitude and volume of its capillaries. The latter theory is here discussed in relation to the experimental data available and to various consequences. T. H. P.

4711. Adsorption of Atomic Hydrogen by Glass and CaF_2. J. H. de Boer and J. J. Lehr. *Zeits. f. phys. Chem.* 22. *Abt. B.* 5–6. *pp.* 423–430, *Sept.*, 1933.—A glass surface takes up 3×10^{15} hydrogen atoms per sq.cm., an amount which corresponds with a monatomic layer. A vacuum sublimed surface of CaF_2 takes up more hydrogen than glass and at a faster rate. Moreover it is more firmly adsorbed. Sintering of the CaF_2 film causes a decrease in the amount of hydrogen taken up. F. J. W.

4712. Discontinuity in the Adsorption of Gases, Vapours and Liquids on Solid Surfaces at the Critical Temperature and Pressure. H. E. Morris and O. Maass. *Canad. J. of Research*, 9. *pp.* 240–251, *Sept.*, 1933.—An apparatus and a technique for studying the adsorption of gases, vapours and liquids on solid surfaces are described. The arrangement permits investigations in the region of the critical temperature and the critical pressure. Results with the system propylene–alumina are given. Adsorption from the gas and vapour phases indicates the formation of a surface complex which is unstable at low pressure and high temperature. The density of the adsorbed phase is greater than that of the bulk phase. There is no discontinuity in adsorption processes with a change from vapour state to gaseous state. No evidence was obtained of an increase in critical temperature on the surface of the solid. Adsorption does not occur from the liquid state, and there is a marked discontinuity in the adsorption curve with a change from liquid state to gaseous state. This is probably due to a change in the forces of attraction between liquid molecules and the solid as compared with the attraction between gaseous or vapour molecules and the solid surface. If this is the case it is further evidence for the discontinuity in the region of the critical temperature, which has been previously observed in other experiments in this laboratory. AUTHORS.

4713. Clean-Up of Hydrogen by Magnesium. A. L. Reimann. *Phil. Mag.* 16. *pp.* 673–686, *Sept.*, 1933.—Clean magnesium used as a "contact-getter" absorbs at room-temperature about 1 molecule H_2 per $1\cdot5 \times 10^6$ molecules of H_2 incident thereon: such H_2 gradually diffuses into the metal slowly, enabling more H_2 to be "gettered"; atomic H is gettered much more rapidly, Mg ultimately retaining one H atom per 6–7 Mg atoms. Accordingly the clean-up of hydrogen is greatly accelerated by passing an ionising electric discharge, and so producing atomic H ("electric discharge gettering"). Mg dispersed from a heated source in the vacuum vessel acts similarly to the clean metal ("dispersal-gettering"). The gettered hydrogen may be re-evolved owing to its vapour-pressure, or by bombardment with electrons of velocity $\nless$ 4 volts, or by CO^+ ions [see Abstract 3307 (1931)]. C. A. S.

4714. Molecular Theory of Interfaces. Part I. M. Volmer. *Die Physik,* 1. 3. *pp.* 141–152, 1933.—A review of recent work on adsorption. F. J. W.

4715. Nature of Active Carbon. E. Berl and L. Reinhardt. *Zeits. f. phys. Chem.* 166. *Abt. A.* 1–2. *pp.* 81–96, *Sept.*, 1933.—The particle-size and form of a number of different types of active carbon have been determined by the X-ray indicator method. The activity of the different forms is not related to the particle size, or to the number of atoms in the surface of the particles. Study of the variation of the shape of the particles on heat treatment or on treatment with potassium indicates that the whole surface is capable of exhibiting the phenomena of activation, and that activity is a specific property of the unsaturated carbon atoms at certain points of the type described by Smekal. [See Abstract 2607 (1932).] H. F. G.

4716. Alteration of the Shape of Isotherms on Progressive Activation of Charcoal. B. Bruns and O. Zarubina. *Kolloid Zeits.* 64. *pp.* 279–287, *Sept.*, 1933.—When carbon is activated by partial combustion in a current of an oxidising gas, its adsorptive power for vapours increases as the combustion proceeds only for vapour pressures near the saturation point. The adsorptive power for vapours at low pressures, however, reaches a maximum when 35 to 50 % has been burnt away. The same holds for the adsorptive power towards dissolved substances. These results are discussed in relation to the mechanism of the activation process. T. H. P.

4717. Elementary Deduction of Gibbs' Adsorption Theorem. F. O. Koenig and R. C. Swain. *J. Chem. Phys.* 1. *pp.* 723–730, *Oct.*, 1933.—The Gibbsian treatment of the thermodynamics of surfaces is very long and abstract. On the other hand the equations designated as "Gibbs' adsorption theorem" in all texts that have come to the authors' attention are only special cases, incompletely or inexactly derived, of the Gibbsian equation for constant temperature, $d\sigma = -\Sigma^{x}_{i=1}\Gamma_i d\mu_i$. An exact elementary deduction of this equation is therefore desirable. Such a deduction is given by means of a thermodynamic engine. Various closely related equations, all for constant temperature, are also deduced. The relation of the equations obtained to the most general Gibbsian equations,

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which include variations of temperature, is indicated. The assumptions underlying the Gibbsian treatment of the thermodynamics of surfaces are discussed briefly. AUTHORS.

See also Abstracts 4792, 5093.

ATOMIC AND MOLECULAR STRUCTURE.

4718. Increase of the Concentration of H^1H^2 by Fractional Evaporation and Rectification. W. H. Keesom, H. van Dijk and J. Haantjes. *K. Akad. Amsterdam, Proc.* 36. 3. *pp.* 248–252, 1933. *Comm. No.* 224*a from the K. Onnes Lab., Leiden.*—A quantity of 40 l. of liquid hydrogen was reduced to ½ l. by fractional evaporation a little above 14° K., and then rectified at 15° K. till a quantity of 4 l. gas was left. This quantity was then reduced to 2 l. by fractional evaporation at 14° K. The specific weight of the sample obtained proved to be 1·51 ± 0·05 % larger than that of ordinary hydrogen. It follows that this hydrogen contains 3 % in volume of H^1H^2. AUTHORS.

4719. Rôle of Kinetic Electron Energy in Inter-Atomic Forces. H. Hellmann. *Zeits. f. Physik,* 85. 3–4. *pp.* 180–190, *Sept.* 4, 1933.—The valency forces between atoms can be interpreted as changes in the mean kinetic energy of the electrons. The division of the total energy of disturbance into kinetic and potential energy is made to a first approximation in the calculation. From the virial principle a general energy relation for a system of atoms is derived. W. R. A.

4720. Nature of the Chemical Bond. Part VII. Calculation of Resonance Energy in Conjugated Systems. L. Pauling and J. Sherman. *J. Chem. Phys.* 1. *pp.* 679–686, *Oct.,* 1933.—The quantum-mechanical treatment previously applied to benzene, naphthalene, and the hydrocarbon free radicals is used in the calculation of extra resonance energy of conjugation in systems of double bonds, the dihydronaphthalenes and dihydroanthracenes, phenylethylene, stilbene, isostilbene, triphenylethylene, tetraphenylethylene, biphenyl, *o, m,* and *p*-diphenylbenzene, and 1, 3, 5-triphenylbenzene. The calculated values, which are in approximate agreement with empirical values from thermochemical data, are used in the discussion of chemical properties and in the formulation of rules regarding conjugation in overlapping systems. [For Part VI see Abstract 3878 (1933).] AUTHORS.

4721. Virial Theorem and Molecular Structure. J. C. Slater. *J. Chem. Phys.* 1. *pp.* 687–691, *Oct.,* 1933.—The virial theorem can be applied to a molecule, assuming that external forces are applied to keep the nuclei fixed. The mean electronic kinetic energy is then the negative of the mean total internal energy, plus a term arising from the virial of the external force. Since the external force is derivable from the knowledge of the total internal energy as function of nuclear position, this theorem gives a means of finding kinetic and potential energy separately for all configurations of the nuclei, as soon as the total energy is known, from experiment or theory. By using simple forms of curve for total energy, for the diatomic molecule, the kinetic and potential energy are derived and discussed. The curves give direct indication of the formation of the covalent bond, in cases where this occurs, by describing the removal of charge from the atoms to the region between the atoms, with resulting decrease of kinetic energy and increase of potential energy. AUTHOR.

4722. Molecular Structure of Ice and Liquid Water. E. L. Kinsey and O. L. Sponsler. *Phys. Soc., Proc.* 45. *pp.* 768–779, *Nov.* 1, 1933.—A lattice, new so far as the hydrogen-ion positions are concerned, and based on the oxygen positions previously determined by Barnes, is proposed for ice. The structure contains the units H^+ and $H^{-}{}_{3}O_{2}$, the latter built so that three hydrogen ions lie at the corners of an equilateral triangle in the plane midway between, and perpendicular to, the line of centres of the two oxygen ions. It consists of neutral chains extending parallel to the c axis and arranged about one another in a manner consistent with the symmetry and oxygen-position requirements. Large polarisation effects arise, and reasons are given why a lattice in which they are produced is preferred to a coordination structure in which they are absent. The structure provides dihydrol as the polymer occurring in both ice and water, evidence for whose existence has arisen from various sources; and by means of a reasonable postulate in regard to the stability of the $H^{-}{}_{3}O_{2}$ ion in the crystal, and in clusters of dihydrol occurring in the liquid, it allows a qualitative explanation to be given of many of the abnormal properties of water and ice. The model is used to calculate the angle θ between the c axis and the line joining an oxygen with a hydrogen ion in the $H^{-}{}_{3}O_{2}$ unit, both when the unit is within the lattice and when it is within dihydrol regarded as isolated. The calculations are not exact, but indicate that $\theta = 30°$ to within a few degrees when the unit is in the lattice. The effect of the lattice on θ is shown to be small (several degrees), whereas the effect on the polarisation of the oxygen is large and is such as to increase it nearly threefold over its value for isolated dihydrol. Use is made of this fact in accounting for the stability of dihydrol in the crystal lattice.

AUTHORS.

4723. Atomic Weights of Radioactive Substances. F. Western and A. E. Ruark. *J. Chem. Phys.* 1. *pp.* 717–722, *Oct.*, 1933.—(1) The isotopic weights of Pb^{206}, Pb^{207} and Pb^{208}, on the chemical scale $O = 16\cdot0000$, are obtained by three distinct methods, using in each case the assumption that they differ by an amount very close to unity. The results for Pb^{206} are these: (1) from packing fraction of lead, $205\cdot96_5$; (2) from study of the packing fraction curve, $205\cdot99_2$; from relative abundance of isotopes in leads of known atomic weight, $206\cdot00_3$. Mean, $205\cdot98_7 \pm 0\cdot03$. By taking into account a recent atomic weight determination on lead from Bedford cyrtolite, reasonable rounded values for the three isotopes are $205\cdot98$, $206\cdot98$ and $207\cdot98 \pm 0\cdot03$. (2) From these values the isotopic weights of the radioactive substances are obtained by adding the mass (and the mass-equivalent of the energy) lost in disintegration. The calculated values for radium and thorium, $226\cdot02 \pm 0\cdot03$ and $232\cdot03 \pm 0\cdot03$, do not agree with the international values $225\cdot97 \pm 0\cdot01$ and $232\cdot12 \pm 0\cdot01$. The calculated weights for U^{238} and U^{234} are $238\cdot04 \pm 0\cdot03$ and $234\cdot04 \pm 0\cdot03$, respectively, while the heretofore accepted atomic weight of U is $238\cdot14 \pm 0\cdot01$. In view of Aston's conclusion that U does not contain more than 3 % of U^{239} or any higher isotope, it appears probable that the accepted value for uranium is somewhat too high. (3) $W - N$ is plotted as a function of N, for the three radioactive series, W being the isotopic weight and N the nearest integer. The graphs obtained are almost linear, and their slopes are nearly identical. In an average way they conform to the equation $W - N = -0\cdot02 + 0\cdot00214\,(N - 206)$.

AUTHORS.

See also Abstracts **4790, 4856, 4926, 4928, 4929, 4935, 4984, 4985, 5041, 5079.**

COLLOIDS.

4724. Continuity of Phases during Sol-Gel Transformation. S. Prakash. *Kolloid Zeits.* 64. *pp.* 293–300, *Sept.*, 1933.—By application of the phase rule to colloid systems, it is shown that a new electrical or charge degree of freedom must be introduced, so that the Gibbs equation requires modification. A jelly with two components represents an equilibrium with a quintuple-point, the phases being : vapour of the solvent, charged disperse phase, mechanically adsorbed solvent, uncharged disperse phase, and hydrated disperse phase. From this point of view, an attempt is made to explain the phenomena of synæresis, thixotropy and swelling. It is suggested that the charge of all the colloidal particles of a solidified jelly need not necessarily be neutralised. Results are of experiments on the dehydration of cerium, zirconium and aluminium hydroxides, thorium arsenate, phosphate and molybdate. The dehydration of these sols and gels over sulphuric acid proceeds linearly with the time, and the curves show no break at the gelatinising point. If a jelly is obtained from a sol, the hydrogen-ion concentration remains constant during the whole course of the gelatinisation. When a sol is converted into a gel, the viscosity follows an experimental law during the first stages in the gradual neutralisation of the charge, but later, during the development of the structure, the viscosity increases more rapidly. With the systems examined, the conductivity of the jellies remains constant during the change of sol to gel, no discontinuity of phase being indicated. During ageing, however, the conductivity increases with the diminution of the surface energy effected by adsorption of the ions. With jellies tending to become opalescent long before solidification, the curves of the extinction coefficients pass the gelatinising point smoothly without a break. The changes in the light-dispersion of the particles are continuous before and after the gelatinising point. T. H. P.

4725. Cataphoretic Behaviour of Gas-Charged Carbon. A. Pilojan, N. Kriworutschko and Nathalie Bach. *Kolloid Zeits.* 64. *pp.* 287–293, *Sept.*, 1933.—The cataphoretic velocity of positive oxygen-charcoal, hydrogen-charcoal, and acid oxidised charcoal in various electrolytes has been measured. In water and in dilute HCl and NaOH solutions in presence of air, non-platinised and platinised charcoals activated at high temperatures show a positive electrokinetic charge. In NaOH at higher concentrations discharge is sometimes observed, this depending probably on the formation of acid surface-oxides. Carbon oxidised for 15 hours at 400° C. is electrokinetically negative and is discharged by $La^{\cdot\cdot\cdot\cdot}$ and $Th^{\cdot\cdot\cdot\cdot}$ ions. Platinised carbon charged with hydrogen is electrokinetically negative in water and in dilute HCl and NaOH solutions and is discharged by $Th^{\cdot\cdot\cdot\cdot}$ ions, marked stability occurring at the zero-point. In a hydrogen atmosphere, the positive electrokinetic charge of carbon previously in contact with air becomes negative as the platinum-content increases. Perfect parallelism exists between the electrokinetic and electrochemical behaviour of carbon in relation to the dependency on the concentration of HCl and NaOH, the gas charge, and the platinum content. T. H. P.

4726. Measurement of Cataphoretic Velocity. S. Komagama. *Electrot. Laborat. Tokyo, Japan, Researches, No.* 348. [114 *pp.*], 1933. *English Abstract.*—An exhaustive discussion of the methods available for mono- and poly-disperse systems. A. S. C. L.

4727. Electrical Properties of Colloids. Part III. Discrepancies between the Activities and Conductivities in Colloidal Solutions. I. N. Mukherjee. *Kolloid Zeits.* 65. *pp.* 72–77, *Oct.*, 1933.—In continuation of earlier work [see Abstract 2682 (1933)], the e.m.f. of alumina sols containing chlorine ions in low-concentration have been measured with both Ag-AgCl and Hg-HgCl electrodes. The activities found for the chlorine ions with the two electrodes agree well. Calculation by means of Pauli and Muttone's data shows here also discrepancy between the observed and calculated specific conductivities. Results obtained with a silicic acid sol containing sodium chloride confirm the observation that the activity of the H-ion increases more rapidly than the concentration of the sol, although the total concentration of the electrolyte in the sol corresponds with the region of dilute solutions. In this case also the discrepancy between the calculated and observed specific conductivities is confirmed. T. H. P.

4728. Streaming Double Refraction in Critical Liquid Mixtures. W. Ostwald and H. Erbring. *Kolloid Zeits.* 64. *pp.* 229–232, *Aug.*, 1933.—A moving column of a critical liquid mixture (*e.g.*, carbon disulphide-methyl alcohol) exhibits double refraction, *i.e.*, it causes brightening of the field when passed between crossed nicols. The effect is ascribed to deformation during flow of the droplets having very small interfacial tension, and is termed morphotropic double refraction.

H. F. G.

4729. Viscosity and Elasticity of Sols. B. Rabinowitsch. *Zeits. f. phys. Chem.* 166. *Abt. A.* 3–4. *pp.* 257–269, 1933.—The velocity of flow of cellite solutions of various concentrations and in various solvents through capillary tubes has been investigated. Over wide ranges of pressure and capillary radius and length, the flow was laminar and stationary. The solutions obey a viscosity law which expresses a non-linear relationship between pressure and fall of velocity and contains two material-constants. This law holds for all the concentrations and solvents examined. From the constants of this expression the coefficient of viscosity, the modulus of elasticity and the relaxation time may be calculated. [See also Abstract 1627 (1930).] T. H. P.

4730. Calcium Acetate Gels. H. Henstock. *Faraday Soc., Trans.* 29. *pp.* 1101–1107, *Sept.*, 1933.—From cold aqueous solution, calcium acetate is precipitated by ethyl alcohol in globules of jelly which then coalesce. The solution in MeOH also forms non-elastic gels when various organic liquids are added. Water need not be present. Physical properties of the methyl-alcogel are described. A. S. C. L.

4731. Elastic Properties of Glycerin-Gelatin Gels and of Gelatin Gels Hardened with Formaldehyde. E. Hatschek. *Faraday Soc., Trans.* 29. *pp.* 1108–1131, *Sept.*, 1933.—Young's modulus, in compression, is determined for gelatin gels containing various amounts of glycerin and cane sugar. Both increase it, but there is no direct relation between the amount added and the increase; this is attributed to differences in rate of ageing of the test pieces. After permanent deformation, the modulus, for prismatic test pieces, remains unchanged in the direction of compression, but increases at right angles to it in the direction of dilation. The effect of hardening by formaldehyde has been investigated and the large increase of the modulus is ascribed to formation of condensation products. This also explains the disappearance of large amounts of formaldehyde from the hardening solution. A. S. C. L.

4732. Influence of the Reaction of the Medium at the Moment of Coagulation on the Structure of Silica Gel. Part I. M. O. Charmadarjan and W. K. Markow. *Phys. Zeits. d. Sowjetunion,* 4. 2. *pp.* 172–184, 1933.—The experimental results recorded show that the pore-volumes of silica gels run parallel to their static activities towards benzene and increase in passing from acid to alkaline gels. The half diameter of the capillaries traversing the gels is considerably greater with alkaline than with acid or neutral silica gels, the varying behaviour of the different gels in the dynamic sorption of vapours being thus explained. The true density of these gels is greater for the alkaline than for the acid products. X-ray examination shows that the crystalline part of the alkaline gels is much greater than that of the acid gels, the neutral ones occupying an intermediate position. The connection between the appearance of synæresis and the process of crystallisation in jellies is confirmed. T. H. P.

CRYSTAL STRUCTURE AND PROPERTIES.

4733. Physics of Solids. B. E. Warren. *Rev. Sci. Instruments,* 4. *pp.* 520–523, *Oct.,* 1933.—An elementary account of the progress of studies in crystal structure. The topics dealt with include typical ionic lattices, homopolar types, organic compounds, metals and intermetallic compounds. Recent work on physico-chemical properties is briefly reviewed, and the amorphous state is discussed. F. I. G. R.

4734. New Analysis of Slater's Compressibility Data for the Alkali Halides. H. M. Evjen. *Phys. Rev.* 44. *pp.* 491–500, *Sept.* 15, 1933.—The variation of interatomic forces with interatomic distances in crystals may be determined empirically from compressibility data. The experimentally possible range of variation in interatomic distance is, however, so small that the form of the force function valid for extrapolation to much greater distances cannot be adequately determined. From an analysis of Slater's compressibility data for the alkali halides [see Abstract 1669 (1924)] it appears that for them the interionic forces of repulsion may be derived from a common force function. Because of the relatively large variation of lattice constant between the different alkali halides it is possible to determine a form for this common force function which is valid for relatively large variations in interatomic separation. The force function so found differs but little from the inverse power or from the exponential forms for small displacements from the equilibrium position. It drops off more rapidly, however, for increasing distances and increases more rapidly for decreasing distances. The solution given has the interesting property that of all possible force functions compatible with Slater's compressibility data it is the least favourable for the formation of a secondary structure. [See following Abstract.] AUTHOR.

4735. Theory of Heteropolar Crystals. H. M. Evjen. *Phys. Rev.* 44. *pp.* 501–509, *Sept.* 15, 1933.—It is shown that the failure of theories of the solid state to account for the stability of ideal crystals cannot be due to inadequacy of the force postulate. A number of existing crystals, if ideal, would be dynamically unstable, with respect to certain variations, for any force postulate compatible with the compressibility data. These crystals cannot be ideal. A possible type of departure from the ideal state is suggested which involves a change of energy comparable with the heat of fusion (in agreement with Zwicky's theory). The change in volume at the melting point may be accounted for. Evidence from the photoelectric properties of these crystals indicates that this proposed type of departure may have physical reality, although undoubtedly accompanied by asymmetries. A consideration of the changes necessary in the energy function to permit the existence of secondary structure indicate that such secondary may exist even in crystals apparently dynamically stable. It is conjectural whether any crystal is thermodynamically stable in the ideal state. A working hypothesis that all crystals have a secondary structure leads to a rational explanation of the doublet nature of residual rays in cubic crystals and to an improved form of Lindemann's law. [See preceding Abstract.] AUTHOR.

4736. X-Ray Investigation of the Copper-Aluminium Alloys. A. J. Bradley and (Miss) P. Jones. *Inst. of Metals, J.* 51. *pp.* 131–157; *Disc.*, 157–162, 1933.—The copper-aluminium system has been investigated using the X-ray powder method. The homogeneous β'-structure is invariably obtained by quenching the powdered alloy. This structure appears to be closely related to the face-centred α-phase. Alloys quenched from the γ-range are indistinguishable from the δ-alloys. The structure of δ-CuAl up to 19 % Al is essentially of the γ-brass type. The arrangement of atoms gives the formula Cu_9Al_4. In the δ'-phase (19–22·5 % Al) the number of atoms in the pseudo-cubic cells falls from 52 to 49. Quenching a two-phase alloy containing 22·8 % Al from 700° C., a single cubic phase (ϵ) is obtained. Friauf's structure [see Abstract 820 (1928)] for the θ-phase ($CuAl_2$) is confirmed. F. J. W.

4737. X-Ray Analysis of the System Lithium-Cadmium. A. Baroni. *Accad. Lincei, Atti*, 18. *pp.* 41–44, *July*, 1933.—The system LiCd was studied thermally and by means of X-rays. By thermal analysis the results of Grube were substantially confirmed and not those of Tammann. By X-ray analysis the compound LiCd was identified. It presents a monometric structure of centred body type CsCl, with elementary mesh of side $a = 3{\cdot}32$ Å and with the coordinates of the atoms Cd (0, 0, 0) Li ($\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$), and of the compound $LiCd_3$ probably purely monometric with the elementary cell of side $a = 8{\cdot}62$ Å and with eight molecules. X-ray analysis does not reveal the compound Li_3Cd found with thermal analysis. J. J. S.

4738. Mixed Crystal Formation in Single and Multi-Crystal Material. E. Schmid and G. Siebel. *Zeits. f. Physik.* 85. 1–2. *pp.* 36–55, *Aug.* 29, 1933.—The behaviour of single and multi-crystal materials was investigated. α-Mixed crystal alloys of Al-Mg, Zn-Mg and Ag-Cu were used and the changes of lattice constants were determined. Within the limits of accuracy of the method, no difference was detected between the constants for single or multi-crystal material. F. J. B.

4739. Crystal-Orientation in Aggregates with Parallel Fibres. W. Jansen. *Zeits. f. Krist.* 86. *pp.* 171–185, *Sept.*, 1933.—Information is given, on the basis of X-ray work, upon the following characteristics: lattice-parallelism, magnitude of the identity periods, habit, likeness of parallel-fibre and spherulitic effects. F. I. G. R.

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4740. Crystal Structure of Cæsium, Thallium and Rubidium Per-rhenates. F. M. Jaeger and J. Beintema. *K. Akad. Amsterdam, Proc.* 36. 5. *pp.* 523–528, 1933.—Like the potassium and silver salts, rubidium per-rhenate is tetragonal-bipyramidal with a structure completely analogous to that of scheelite: $a_0 : c_0 = 5 \cdot 810 : 13 \cdot 171$ Å.; calculated density 5·0. On the other hand, cæsium and thallous per-rhenates are orthorhombic, but they possess a decidedly pseudo-tetragonal character. For $CsReO_4$, $a_0 : b_0 : c_0 = 5 \cdot 73 : 5 \cdot 98 : 14 \cdot 26$ Å.; calculated density 5·17. For $TlReO_4$, $a_0 : b_0 c_0 = 5 \cdot 63 : 5 \cdot 80 : 13 \cdot 33$ Å.; calculated density 6·90. The structure of cæsium and thallium per-rhenates is quite analogous to that of ammonium, rubidium and thallium osmiamates, that of cæsium osmiamate being different. On the contrary, the structures of potassium, rubidium and silver per-rhenates are perfectly analogous to that of potassium osmiamate, which is that of scheelite [see Abstracts 32 and 33 (1933).] T. H. P.

4741. X-Ray Investigation of the System Nickel-Oxygen-Water. M. le Blanc and E. Möbius. *Zeits. f. Elektrochem.* 39. *pp.* 753–754, *Sept.*, 1933.—X-ray investigation shows that there is no evidence for the existence of the compounds $Ni_2O_3 \cdot H_2O$, $Ni_2O_3 \cdot 2H_2O$, and the hydrates of the hypothetical oxides Ni_3O_4 and Ni_6O_7, which were mentioned by Cairns and Ott [see Abstract 1689 (1933)]. J. T.

4742. Crystal Structure of p-Aminoazobenzene. M. Prasad and M. R. Kapadia. *Indian Journ. Phys.* 8. *pp.* 77–81, *July* 15, 1933.—The dimensions of the unit cell of these monoclinic prismatic crystals are: $a = 13 \cdot 69$, $b = 5 \cdot 604$ and $c = 14 \cdot 18$ Å.; $\beta = 81° 49'$. The density is 1·174 and the unit cell contains four molecules. As with azobenzene, and *o*-azotoluene, it is probable that the molecules in the unit cell lie along the direction of $c \sin \beta$. T. H. P.

4743. Structure of Stilbene and Tolane. M. Prasad. *Phil. Mag.* 16. *pp.* 639–640, *Sept.*, 1933.—Stilbene and tolane are pseudo-orthorhombic, the dimensions being $a = 12 \cdot 20$ Å.; $b = 5 \cdot 72$ Å.; $c = 29 \cdot 0$ Å., and $a = 12 \cdot 80$ Å.; $b = 5 \cdot 68$ Å; $c = 28 \cdot 4$ Å. respectively. It is inferred from the similarity between the results on azobenzene and those on stilbene and tolane that the molecules in the unit cells of the latter lie with their lengths along the $(20\bar{1})$ axis. The length of the cell in this direction is the same in tolane as in azobenzene. J. T.

4744. X-Ray Study of p-Diphenylbenzene. Lucy W. Pickett. *Roy. Soc., Proc.* 142. *pp.* 333–346, *Oct.* 2, 1933.—*p*-Diphenylbenzene crystallises in the monoclinic prismatic class with two molecules in the unit cell whose dimensions are $a = 8 \cdot 08$ Å., $b = 5 \cdot 60$ Å., $c = 13 \cdot 59$ Å., $\beta = 91° 55'$. The space group is $P\ 2_1/a$. The results of a structure analysis by trial and error and by Fourier analysis give evidence that the molecule is planar in form; that it consists of regular hexagons of carbon atoms 1·42 Å. apart with a probable distance of 1·48 Å. between the hexagons; and that its position may be defined by two successive rotations of 24° and 15·3° about the *c* and *b* axes from an original position in the (100) plane parallel to the *c* axis. Probable positions for the thirty-six atoms of the unit cell are enumerated. AUTHOR.

4745. Crystal Axes of Single-Crystal Wires. R. Roscoe and P. J. Hutchings. *Phil. Mag.* 16. *pp.* 703–707, *Sept.*, 1933.—An apparatus is described enabling the angle between the axis of the wire and the glide plane to be measured directly, and a method given for thence rapidly deducing the orientation of the crystal axes when the distance between adjacent slip bands is small, *e.g.*, in cadmium where it averages 1·0 μ [see Abstract 38 (1933)]. C. A. S.

4746. Direction of Growth of Acicular Crystals of Glucose Penta-acetate and Cellobiose Octa-acetate. K. Hutino. *Inst. Phys. and Chem. Research. Tokyo, Sci. Papers, No.* 445. *pp.* 270–272, *Sept.,* 1933. *In German.*—Crystal aggregates of these compounds, composed of parallel needle-shaped crystals, have been obtained and X-ray diagrams with radiation perpendicular to the axis of the needles, and also powder diagrams, are shown. The lattice-plane distances are given and the fibre-periods are 5·72 ± 0·07 and 5·59 ± 0·07 Å. for glucose penta-acetate and cellobiose octa-acetate respectively. The fibre-periods are hence small and almost identical, but the lattice-plane distances perpendicular to the fibre axis are large. T. H. P.

4747. Complex Indicatrix of Weakly Absorbing Rhombic Crystals. M. Berek and F. Strieder. *Zeits. f. Krist.* 86. *pp.* 212–224, *Sept.,* 1933.—By means of a Berek microphotometer used in conjunction with a polarisation microscope, the absorption of light by a number of weakly absorbing rhombic crystals is investigated. The pleochroism and absorption coefficients parallel to *a*, *b* and *c*, for three wave-lengths, are tabulated for specimens of andalusite (two sources), cordierite, anhydrite, brookite and astrophyllite; and these data are employed to determine the orientations of the four "spiral" axes (*Windungsachsen*). Tables of the orientation of polarisation axes, absorption axes, and "spiral" axes relative to the crystallographic axes, and stereographic projections, are given. C. B. A.

4748. Crystal Parameters of Metals under Reduced Pressure. E. A. Owen and E. L. Yates. *Phil. Mag.* 16. *pp.* 606–610, *Sept.,* 1933.—A design of precision camera suitable for the investigation of materials at high temperatures *in vacuo* is briefly described. The parameters of four spectroscopically pure elements, namely, gold, platinum, palladium and rhodium, were measured with this camera. Each specimen was heated *in vacuo* to a high temperature, and was maintained at this temperature for a definite period of time. It was then allowed to cool slowly to atmospheric temperature and exposed *in vacuo* to the X-rays. The values of the parameters under these conditions confirmed those previously published for these elements. AUTHORS.

4749. Long-Wave X-Rays for Crystal Analysis. G. Hägg. *Zeits. f. Krist.* 86. *pp.* 246–252, *Sept.,* 1933.—An apparatus is described for the production and use of long-wave X-rays for crystal analysis. It consists essentially of a box-shaped cast brass enclosure into which the antikathode end of an X-ray tube is built. Three windows are provided in the tube and in general three focussing cameras are used. These are situated within the brass enclosure which is evacuated. A film-blackening effect is described which it is suggested might be due to secondary radiation from the residual air in the camera. It can be overcome by covering the windows with Al foil and pumping the brass enclosure down to force-vacuum pressure only. Non-metallic antikathodes cannot be used on account of the heat developed. Antikathodes of Ca, Al and Mg are satisfactorily used. The results of the examination of a few alloys by long-wave X-rays are referred to. J. T.

4750. Crystal Structure Model. G. Glockler. *Rev. Sci. Instruments*, 4. *p.* 529, *Oct.*, 1933.

See also Abstracts 4722, 4758, 4863, 4864, 4865, 4909, 4951, 4968, 4969, 5030, 5066, 5069.

DENSITY.

4751. Density of a Vapour in Equilibrium with a Liquid near the Critical Temperature. J. S. Tapp, E. W. R. Steacie and O. Maass. *Canad. J. of Research*, 9. *pp.* 217–239, *Sept.*, 1933.—An account is given of the outstanding work done and theories developed in connection with the critical phenomena during the last century. It was because of certain observations made in this laboratory a short time ago upon reaction rates at the critical temperature that the present investigation was begun with a view to providing more definite data concerning the density of both the liquid and gas in the region of the critical point. Experimental conditions have been kept under the most rigid supervision and previous errors eliminated or evaluated. A distinctly new technique has been developed, utilising quartz spirals, for determining the density of both the liquid and gaseous phase almost simultaneously, up to, and past, the point where the meniscus vanishes. The results have been compiled from a great many observations taken over a period of two years upon eight separate units. In general, good agreement has been obtained in all but one case, and a probable solution has been advanced for the exception. Primarily, the paper is an experimental one designed to fill an important gap in previously recorded data. Extensive theoretical deductions have been purposely omitted because of the radical nature of the findings; and it would be necessary to proceed further with the work before anything really definite might be concluded. Briefly, it might be stated that the results cast considerable doubt upon van der Waals' classical theory of the continuity of state. AUTHORS.

See also Abstracts 4718, 4754, 4755, 4792, 4908, 5041.

DIFFUSION AND OSMOSIS.

4752. Diffusion of Metals in Mercury. F. Weischedel. *Zeits. f. Physik*, 85. 1–2. *pp.* 29–35, *Aug.* 29, 1933.—The diffusion of Zn and Cd in Hg is investigated. The methods of measurements are based upon the changes in electrical conductivity caused by the changes in concentration. F. J. B.

See also Abstract 5043.

ELASTICITY AND PLASTICITY.

4753. Boundary Conditions in Two-Dimensional Elastic Theory. N. Muschelišvili. *Zeits. f. angew. Math. u. Mechanik*, 13. *pp.* 264–282, *Aug.*, 1933.—The method of conformal representation is employed to solve anew certain fundamental problems in two-dimensional elasticity. Stress is laid here upon applications to practical problems, chiefly concerning boundary conditions in circular and elliptical plates, and in plates containing elliptical apertures. J. P. A.

4754. Isopycnals of Liquid Helium. Part I. W. H. Keesom and (Miss) A. P. Keesom. *K. Akad. Amsterdam, Proc.* 36. 5. *pp.* 482–487, 1933. *Comm. No.* 224d from the *K. Onnes Lab., Leiden.*—Isopycnals of liquid helium have been measured between the saturated vapour pressure and about 25 atmospheres, and between about 1·15 and 4·2° K. The isopycnals consist of two branches, corresponding to helium II and helium I respectively. These branches meet at the λ-curve at a sharp angle, *i.e.* $(\partial p/\partial T)_v$ suffers a discontinuity at this point. The pressure coefficient of liquid helium II being negative in the whole region investigated, an isentropic as well as an isenthalpic expansion of liquid helium II will be connected with increase of temperature. The phenomenon of maximum density becomes more striking at higher pressures. [See following Abstract.] AUTHORS.

4755. Isopycnals of Liquid Helium. Part II. W. H. Keesom and (Miss) A. P. Keesom. *K. Akad. Amsterdam, Proc.* 36. 6. *pp.* 612–615, 1933. *Comm. No.* 224*e from the K. Onnes Lab., Leiden.*—Measurements on the isopycnals of liquid helium were continued to 35 atmospheres. Part of the solidification curve could be determined more accurately. The position of the λ-point in this curve was found to be: T = 1·753°K, P = 29·91 atmospheres. Undercooling of liquid helium I was observed. [See preceding Abstract.] AUTHORS.

4756. Elastic Constants of Single Crystals of Copper. R. Kimura. *Tohoku Univ., Sci. Reports,* 22. *pp.* 553–564, 1933. *In English. Report No.* 306 *from the Research Inst. for Iron, Steel and other Metals.*—From Young's modulus of elasticity *E* and the modulus of torsion *n* in various directions, the Voigt moduli were found for monocrystal copper at room-temperature: $S_{11}\cdot 10^{12} = 1\cdot 291$, $S_{12}\cdot 10^{12} = -0\cdot 523$, $S_{44}\cdot 10^{12} = 1\cdot 636$; $E_{[111]} : E_{[100]} = 2\cdot 06$, $n_{[111]} : n_{[100]} = 1/1\cdot 81$. These values are all given in C.G.S. units. AUTHOR.

4757. Deformation of Elastic Plasters. Parts VII–IX. E. Almansi. *Accad. Lincei, Atti,* 17. *p.* 886, *June* 2; 18. *pp.* 3–9, *July,* and *pp.* 77–82, *Aug.*, 1933.—[For Parts I–VI see Abstract 3318 (1933).]

4758. Lattice Distortion in Nitrided Steels. W. A. Wood. *Phil. Mag.* 16. *pp.* 719–727, *Sept.*, 1933.—An X-ray investigation is made of changes produced in steels when case-hardened by the nitriding process. A thin surface layer of nitride is formed, covering a case of steel characterised by an abnormally diffused and weakened spectrum, and by large hardness values. It is suggested in explanation that the atomic lattice suffers distortion during the process, and that the electron distribution is seriously disturbed. An outline is given of a possible way in which such a disturbance could increase hardness. Evidence supporting the suggestion is adduced. J. P. A.

See also Abstracts 4729, 4731, 4734, 4735, 4818, 5067.

GRAVITATION.

See Abstract 4812.

HYDRODYNAMICS AND AERODYNAMICS.

4759. Aerodynamic Characteristics of Automobile Models. R. H. Heald. *Bureau of Standards, J. of Research,* 11. *pp.* 285–291, *Aug.*, 1933.—In the investigations described in this paper the drag coefficients were found to vary from 0·0018 lb./ft².$/$m.p.h². for the model representing an automobile of 10 years ago to 0·0014 for the model representing an automobile of the present. Elimination of the fenders and other projections together with pronounced fairing of the body of one model reduced the drag coefficient to 0·0006. Lateral and longitudinal forces were also measured. The lateral force was found to vary approximately as the angle of the relative wind if this was less than 20° to the direction of motion of the automobile. Very little variation in longitudinal force coefficient was observed with this range of angles. AUTHOR.

4760. Interference Due to Walls of a Wind-Tunnel. L. Rosenhead. *Roy. Soc., Proc.* 142. *pp.* 308–320, *Oct.* 2, 1933.—This paper discusses the validity of the approximate method of determining the interference on aerofoils due to wind-tunnels. The correct solutions of various cases recently investigated by Theodorsen are given, and are illustrated by diagrams and tables. AUTHOR.

4761. Free Oscillations of an Annular Sheet of Water Bounded by Non-Concentric Circles. H. Arakawa. *Geophys. Mag. Tokyo,* 7. *pp.* 161–164, *Aug.*, 1933. *In English.*—The theory of small oscillations of an annular sheet of water bounded by non-concentric circles is treated by the method of conformal representation. J. S. G. T.

4762. Path and Stability of a Local Vortex Moving Round a Corner. A. Miyadzu. *Phil. Mag.* 16. *pp.* 553–562, *Sept.*, 1933.—The effect of direction of rotation upon the path and stability of a vortex in the neighbourhood of a corner is discussed by the method of images. J. S. G. T.

4763. Eddies in an Incompressible Viscous Fluid in Steady Planar Motion. A. Ratib. *Comptes Rendus,* 197. *pp.* 575–576, *Sept.* 4, 1933.—It is demonstrated mathematically that within a region Δ, defined as being such that ψ (x, y) and its first order partial derivatives are continuous, the eddy cannot have either its maximum or its minimum. H. F. G.

4764. Origin of Turbulent Flow in Tubes. H. Kurzweg. *Ann. d. Physik,* 18. 2. *pp.* 193–216, *Sept.*, 1933.—A photographic and kinematographic study of the production of turbulence in water flowing in tubes is detailed, following the lines of work by Naumann [*Diss.* Leipzig], particular attention being directed to the effect of the shape and size of the entrance to the tube upon the incidence of turbulence. It appears that turbulence commences when the disturbing circulation referred to by Schiller attains the critical value 1170. J. S. G. T.

4765. Application of Statistical Mechanics to the Theory of Turbulent Fluid Motion. J. M. Burgers. *K. Akad. Amsterdam, Proc.* 36. 3. *pp.* 276–284; 36. 4. *pp.* 390–399; 36. 5. *pp.* 487–496 *and* 36. 6. *pp.* 620–628, 1933.—In continuation of preceding work [see Abstract 3224 (1929)], the author develops a statistical theory of fluid motion characterised by the circumstance that only quantities defined for instantaneous observed modes of motion are considered, while the fact that the motion must have a stationary character over a long period of time is introduced explicitly. J. S. G. T.

4766. Constants of Hagenbach's Correction to Poiseuille's Law. M. Lippke. *Zeits. f. techn. Physik,* 14. 10. *pp.* 412–418, 1933.—The author contends that the analytical expression of Poiseuille's law, including Hagenbach's correction for pressure drop at the ends of the tube (as formulated by Erk) has no real physical justification as the constants and coefficients concerned depend on the velocity of flow and the diameter of the tube. By integration of the fundamental hydrodynamic equation, a result is derivable which agrees completely with experimental results. The viscosity of a fluid as ordinarily determined, is dependent upon the velocity of flow and the diameter of the viscometer tube. By choice of a suitable pressure difference, the flow conforms exactly with Poiseuille's law. J. S. G. T.

4767. Representation of the Flow of Gases at Low Pressures by Means of Reynolds Numbers. H. Ebert. *Zeits. f. Physik*, 85. 9–10. *pp*. 561–564, *Sept*. 30, 1933.—The flow of gases at low pressures can be conveniently represented diagrammatically by choosing Reynolds numbers and the resistance numbers, defined as customary in hydrodynamics, as coordinates. Laminar flow and molecular flow are then represented by straight lines to which the experimental curve approximates in appropriate reigons of pressure. J. S. G. T.

KINETIC THEORY OF MATTER.

4768. Anomalies in the Reflection and Diffraction of Molecular Rays from Crystal Cleavage Faces. Part I. R. Frisch and O. Stern. Part II. R. Frisch. *Zeits. f. Physik*, 84. 7–8. *pp*. 430–447, *Aug*. 7, 1933.—The curves obtained by the reflection and diffraction of molecular rays from the cleavage faces of crystals show characteristic irregularities which are difficult to interpret. It is suggested that these irregularities may be connected with the adsorption of radiation molecules on the crystal. The appearance of sharp "*Dellen*" in the reflection and diffraction curves possesses an experimentally determined regularity. A "*delle*" appears when the molecules leaving the crystal possess determined impulse components relative to the crystal grating. Only two crystal axes influence the effect. W. R. A.

4769. Intensity Measurement of Molecular Rays. I. Estermann and O. Stern. *Zeits. f. Physik*, 85. 3–4. *pp*. 135–143, *Sept*. 4, 1933.—The method depends on the increase in electron current due to the reduction in the space charge, when molecules are ionised in the neighbourhood of a hot wire surrounded by a cylindrical anode. Two arrangements are tried: (1) the molecules condensed on the anode; (2) not condensed; the latter is especially applicable to heavy metals and the anode is then heated. The variation of the anode current with change of anode potential, current strength, anode heating current and gas pressure was determined, the actual values for maximum sensitivity depending on the design of the apparatus. F. C. C.

4770. Molecular Scattering in Gases. Part I. Method of Crossed Molecular Beams. R. G. J. Fraser and L. F. Broadway. Part II. Collision of Sodium and Potassium Atoms with Mercury. L. F. Broadway. *Roy. Soc., Proc.* 141. *pp*. 626–641, *Sept*. 1, 1933.—The apparatus for studying directly collision phenomena in gases by using crossed molecular beams is described in detail. A preliminary application of the method has been made by investigating the scattering of molecular beams of sodium and potassium in *trans*-di-iodo-ethylene vapour throughout the angular range 2°–12°. The decay of the intensity of the molecular beams of sodium and potassium scattered in a stream of mercury vapour has been measured as a function of the angular aperture of the beam system. Results are interpreted by the collision theory of Massey and Mohr. W. R. A.

4771. Brownian Motion. M. Satô. *Tohoku Univ., Sci. Reports,* 22. *pp.* 599–613, *Aug.,* 1933. *In German.*—Apparatus for the study of Brownian motion described. Mathematical calculation of the movements of translation and of rotation to be expected in this apparatus in the case of particles of elliptical, circular, square and triangular projection. A. D.

4772. Influence of Heat Flow on Brownian Movement. Part III. M. Satô. *Zeits. f. Physik,* 85. 5–6. *pp.* 403–408, *Sept.* 14, 1933.—The effect of a directed flow of heat upon Brownian motions worked out on the basis of gas-theory. There is an effect, due to a term of the second power in heat-flow; but this is too small to be observed, except with a single particle moving in a rarefied gas. [For Part II see Abstract 3925 (1933).] A. D.

See also Abstracts 4983, 5075, 5076, 5078.

MATHEMATICAL METHODS. THEORY OF MEASUREMENTS. UNITS AND DIMENSIONS.

4773. Mechanical Adjustment of Observations by Least Squares. B. Germansky. *Zeits. f. techn. Physik.* 14. 9. *pp.* 370–372, 1933.—In the case where a and b are to be determined in the equation $y = ax + b$ from observations of x and y, the values which would be given by the method of least squares may be obtained mechanically. The observed points are plotted on graph paper, and pins stuck into the paper at points simply related to these. Rubber bands parallel to the axis of y, are stretched, one over each pin, and passing over a metal rod which automatically takes up the position of the best straight line to represent the observations. J. H. A,

4774. Probability and Chance in the Theory of Statistics. M. S. Bartlett. *Roy. Soc., Proc.* 141. *pp.* 518–534, *Sept.* 1, 1933.—The distinction between chance and probability is emphasised, and an attempt is made to show why exact arguments about chance are more fundamental as a basis for statistical theory than the formula for inverse probability which in statistics is a hybrid of exact chance and unknown prior probabilities. A. J. McC.

4775. Machine for Dividing Scales of Varying Increment. Bettine M. Davies. *Journ. Sci. Instruments,* 10. *pp.* 314–318, *Oct.,* 1933.—A description is given of a dividing machine incorporating a special device for dividing thermometer and other scales of unequal increment. The device employs a flexible metal strip which can be set in a given curve according to the calibration of the thermometer. The curve of the strip adjusts the exact position of the dividing tool in relation to the work. Details are given of the operation of the machine and a typical scale is shown. AUTHOR.

See also Abstracts 4810, 4811, 4815, 5068.

MECHANICS, CLASSICAL.

4776. Two Theorems on Energy Exchange in Collisions. A. Bloch. *Zeits. f. techn. Physik,* 14. 9. *pp.* 368–370, 1933.—The theorems, proved from ordinary mechanical principles, are: (1) the work done against friction when there is a finite amount of sliding during a collision, is equal to the product of the tangential impulse and the mean velocity (*i.e.*, half the sum of the initial and final velocities) ; (2) the work done in deforming the bodies is the product of the normal impulse and the mean velocity of compression. J. H. A.

4777. Photographic Recording Accelerometer. P. Libessart. *Rev. d'Optique*, 12. *pp.* 302–317, *Aug.*, 1933.—The author employs the light reflected from the sun by a polished sphere to trace the space-time curve of a projectile on a chronographic record. He has studied in this way the acceleration of the projectile in the barrel of the gun, the vibrations of both projectile and gun and the velocity of the gas at the muzzle. The instrument is described in detail and illustrated in the paper. Some records are given and their interpretation is described. J. W. T. W.

See also Abstract 4980.

MECHANICS, QUANTUM.

4778. Dirac's Equation for the Many-Electron Problem and Multiplet Structure. M. Hayakawa. *Phys. Math. Soc., Japan, Proc.* 7. *pp.* 331–335, *Aug.*, 1933. *In German.*—A list of formulæ in connection with this problem is given. G. C. McV.

4779. Hamiltonian Dynamics of Function Space. C. Lanczos. *Zeits. f. Physik*, 85. 1–2. *pp.* 107–127, *Aug.* 29, 1933.—Amplifying and improving upon the discussion of a previous paper [see Abstract 2794 (1933)], the author investigates the reality restriction on the Hamiltonian function H(p, q). This leads to a derivation of Dirac's wave equation from the Hamiltonian dynamics of a point in Hilbertian function space, by a more general and self-consistent method than previously. A set of equations is also deduced which is formally identical with the Maxwell system of electromagnetic equations, but there is an essential difference in interpretation. W. S .S.

4780. Quantisation of Kramers and Pauli Model. P. M. Davidson. *Roy. Soc., Proc.* 142. *pp.* 269–274, *Oct.* 2, 1933.—It is shown that the quantised motions which the old quantum theory permits in simple Kramers and Pauli diatomic models are not limited to those specified by the original authors. The present quantised motions and their energy formulæ offer a close analogy to those given by the wave mechanics for the corresponding molecule. AUTHOR.

See also Abstracts 4719, 4720, 4721, 4765, 4783, 4784, 4907, 5009.

RELATIVITY AND ETHER.

4781. Clock Problem in Relativity. (Second Paper). J. W. Campbell. *Phil. Mag.* 16. *pp.* 529–544, *Sept.*, 1933.—A solution of this problem by the use of moving axes is given. The results are the same as those obtained previously [see Abstract 1344 (1933)]. G. C. McV.

4782. Explanation of the FitzGerald Contraction in Optics. A. Larmor. *Phil. Mag.* 16. *pp.* 610–617, *Sept.*, 1933.—The various conflicting views on the significance of the FitzGerald contraction which appear in the textbooks can be partially reconciled by a simple explanation, on the basis of the existence of rays, without invoking a four-dimensional world. An investigation of the wave-front from a moving source leads to the view that when a source of light moves with uniform velocity in a given direction, the phase of the light moves, relative to the source, faster than the amplitude in the same direction. All optical distances parallel to this direction are then increased in the ratio $\beta : 1$. Similar considerations lead to interpretations of the light-quantum and of the mass-coefficient of a particle of mass m_0. C. B. A.

4783. Dirac Equations in the Case of Semi-Vectors. A. Einstein and W. Mayer. *K. Akad. Amsterdam, Proc.* 36. 5. *pp.* 497–516, 1933. *In German.*—The theory of semi-vectors and spinors is briefly recapitulated and the following matters discussed: (1) derivation of the most general form of Hamiltonian function and the generalised Dirac equations deduced therefrom; (2) successive transformation of these equations to a canonical form involving not more than three arbitrary constants; (3) deduction of the corresponding de Broglie waves for particles at rest, and (4) physical interpretation of the results. J. S. G. T.

4784. Fission of the Most Natural Field Equations for Semi-Vectors into Spinor Equations of Dirac Type. A. Einstein and W. Mayer. *K. Akad. Amsterdam, Proc.* 36. 6. *pp.* 615–619, 1933. *In German.*—In a previous paper [see preceding Abstract] it has been shown that the de Broglie wave system expressed in canonical form in the theory of semi-vectors can be resolved into two wave types of spinor character, presumably associated respectively with the electron and proton. It is now shown that this process of fission is applicable not only to the de Broglie wave system of equations, but to the system of semi-vector equations in general, two spinor systems being produced. J. S. G. T.

4785. Interpretation of Einstein's Unified Field Theory. W. H. McCrea. *Phil. Mag.* 16. *pp.* 707–719, *Sept.*, 1933.—A method is developed for analysing the field-equations of a given unified field theory of electricity and gravitation, into sets representing gravitational and electromagnetic effects respectively. This can usually be done only in the first approximation. The method is applied in particular to the theory of teleparallelism and it is shown that this theory involves a certain ambiguity so that the same ennuple field cannot completely represent the same electric field for all observers. The question of the trajectories of particles, usually neglected in unified field theories, is shown to be of great importance in relation to the interpretation of the gravitational part of the field-variables. G. C. McV.

4786. E. A. Milne's Theory of World-Structure. H. P. Robertson. *Zeits. f. Astrophysik,* 7. *pp.* 153–166, *Sept.*, 16, 1933. *In English.*—It is shown that E. A. Milne's kinematical theory of the expansion of the universe is included within the theory of general relativity. The discussion is carried on from the point of view of the transformations of coordinates involved in the two methods of approach. Milne's "extended principle of relativity," it is suggested, is nothing more than the uniformity postulate of relativistic cosmology. The general conclusion is that Milne's method differs from that of general relativity only in that, in the former, it is laid down *a priori* that gravitation is not to have any effect on the metric of space-time. It is also clearly demonstrated that cosmic time is as much a feature of Milne's treatment as it is of the relativistic one. [See following Abstract.] G. C. McV.

4787. E. A. Milne's Theory of World Structure and the Expansion of the Universe. H. Dingle. *Zeits. f. Astrophysik,* 7. *pp.* 167–179, *Sept.* 16, 1933. *In English.*—A critical discussion of Milne's kinematical theory of the expansion of the universe made on the assumption that it is not reducible to the theory of relativistic cosmology. Attempts are made to discover any possible observational facts which could discriminate between the two theories. [See preceding and following Abstracts.] G. C. McV.

4788. World Structure. E. A. Milne. *Zeits. f. Astrophysik,* 7. *pp.* 180–187, *Sept.* 16, 1933. *In English.*—The author gives his replies to various criticisms raised by Robertson and Dingle [see two preceding Abstracts]. He also gives the reasons which lead him to the belief that his principle of extended relativity is not the same as the uniformity principle of relativistic cosmology and that he is, therefore, not merely obtaining a particular case of the latter theory by a special method. G. C. McV.

4789. Spherical Mass-Particle in de Sitter's World. E. Reichenbächer. *Zeits. f. Astrophysik,* 7. *pp.* 208–221, *Sept.* 16, 1933.—It is pointed out that the well-known de Sitter universe containing a single massive particle will exhibit the phenomenon of the recession of the nebulæ. The geodesics of this space-time are worked out in some detail. G. C. McV.

SOLUTION.

See Abstracts 4908, 4918.

SURFACE TENSION AND COHESION.

4790. Surface Tension and Complex-Formation in Non-Aqueous Salt Solutions. P. P. and N. S. Kosakewitsch. *Zeits. f. phys. Chem.* 166. *Abt. A.* 1–2. *pp.* 113–135, *Sept.,* 1933.—In concentrated solutions most salts increase the surface tension of organic solvents in proportion to their concentration, but in more dilute solutions deviations occur to an extent increasing with the tendency to form complexes. In only few cases can the influence of the true surface tension of the solute on that of the solution be followed, this influence being mostly masked by the action of other factors. Only in so far as it increases the number of particles in the solution has electrolytic dissociation of salts a slight influence on the ability of salts to raise the surface tension of the solvent. Especially in concentrated solution, salts increase the surface tension the more markedly as the solvation of the undissociated salt molecule increases. A relationship can be traced between the magnitudes and structure of the salt-ions and the capacity of the salt to increase surface tension, but only with solvents of one and the same character (alcohols) is this completely possible. For this case the normal lyotropic kation series $Li > Na > K$ and the reversed lyotropic anion series $I > Br > Cl$ are established. With the salts examined the reversed anion series reproduces the solvation relationships of undissociated salt molecules, whereas with water the lyotropic actions arise from the ion solvation, even in quite concentrated solutions. In the homologous alcohol series the negative capillary activity of the solutions (salts and non-electrolytes) diminishes with increase in the number of C atoms in the molecule of the solvent. The higher alcohols (also ethyl) exert a differentiating action on the ability of various salts to raise the surface tension of the solvent. The " strong " salts in this connection are, not those which are more highly dissociated, but those more highly solvated, *e.g.*, LiI compared with LiCl, LiBr and NaI, or ZnI_2 compared with $CaCl_2$ and NaI. T. H. P.

V. 19

4791. Liquid Drops on the Surface of the Same Liquid. L. D. Mahajan. *Zeits. f. Physik*, 84. 9–10. *p.* 676, *Aug.* 12, 1933.—When strong sunlight is used to illuminate the drops Newtonian colours may be observed by means of a strong microscope. If a bright light is concentrated between the drops and the surface on to a screen a fine layer of diffuse light is observed between the drop and the surface. This layer is shaped to a concave convex form. It therefore appears that a very thin layer of the surrounding medium must be lying between the drops and the surface. [See also *Kolloid Zeits.* 65. *pp.* 20–23, *Oct.*, 1933.] W. R. A.

4792. Solid-Liquid-Air Contact Angles and their Dependence upon the Surface Conditions of the Solid. F. E. Bartell and A. D. Wooley. *Am. Chem. Soc., J.* 55. *pp.* 3518–3527, *Sept.*, 1933.—The angles of contact θ of α-bromonaphthalene and acetylene tetrabromide in pyrex and silica capillaries (radius r) were determined by measuring the capillary elevation h and the surface tension T, and substituting in the formula $T = rhdg/2 \cos \theta$ using values of T determined by the drop weight method as standardised by Harkins and values of the density d determined in a special form of pyknometer. The clean tubes were subjected immediately prior to the observations to treatment with water vapour and to heat treatment. A standard method of treatment results in a characteristic reproducible advancing contact angle with a given liquid. By applying appropriate pre-treatment to the surface the advancing contact angle can be made equal to the characteristic receding contact angle which is sensibly independent of the treatment of the solid prior to the wetting with the liquid. The difference between the advancing and receding contact angles is ascribed to changes in the surface structure of the solid due to its immediate pre-treatment. In the case of a receding angle this consists of its wetting by the experimental liquid, and therefore results in a constant receding contact angle. P. H. B.

TIME (STANDARDS, MEASUREMENTS, APPARATUS).

4793. Frequency and Behaviour of the Quartz Clock of the Physikalisch-Technischen Reichsanstalt. A. Scheibe and U. Adelsberger. *Ann. d. Physik*, 18. 1. *pp.* 1–25, *Sept.*, 1933. *From the Reichsanstalt.*—After explaining the meaning of various frequency and rate values of the quartz clock, details are given of an extended series of observations. It is shown that for an observation period of about 30 days, agreement between the measured and absolute frequency can be obtained to 1 or 2 parts in 10^8, or to 0·001–0·002 sec. The methods of measuring the " mean " and " momentary " values are described. The latter can be determined with an accuracy of ± 1 part in 10^9, or 0·0001 sec. Observations, extending over many months, of the Nauen time signals are tabulated and it appears that errors have occurred of as much as 20 or 30 $\times 10^{-3}$ sec., the mean rate difference being ± 0·009 sec. for the year 1932. From this it is deduced that the variation of rate of the mean astronomical clock of the time institute is ± 0·007 sec. for the period in question. [See also Abstract 500 (1933).] A. W.

VACUA, HIGH.

See Abstract 4713.

VISCOSITY, FRICTION AND LUBRICATION.

See Abstracts 4766, 4767, 4971.

ASTRONOMY AND ASTROPHYSICS.

COMETS AND METEORS.

4794. Leonid Meteors of 1932. C. P. Olivier. *Am. Phil. Soc., Proc.* 72. *pp.* 215–227, 1933.—Fourteen parties were organised within a radius of 150 miles from Philadelphia, U.S.A., to observe the Leonids of 1932, Nov. 14 to 19. The maximum shower occurred on the night of Nov. 15–16. Of the 1861 meteors observed (including observations of the same meteor from two or more stations), the paths of 928 were plotted on maps, and heights were determined for 87. Two Leonid fireballs left long-enduring trains, one of which was photographed. Their directions and velocities were deduced, and give valuable information about the winds in the upper atmosphere. In different strata these differ both in velocity and direction, and there is clear evidence of rising currents at a great height. M. A. E.

DYNAMICAL PROBLEMS (ASTRONOMICAL).

4795. Limiting Values of Adiabatic Invariants and Problem of Variable Mass. D. Graffi. *Accad. Sci. Torino, Atti*, 68. 4–10. *pp.* 459–482, 1933.—The results of a previous paper [see Abstract 3402 (1933)] on the limiting values of certain adiabatic invariants are applied to the problem of two bodies of variable mass. A. J. McC.

NEBULÆ.

4796. Classification of Planetary Nebulæ. R. H. Stoy. *Observatory*, 56. *pp.* 269–272, *Sept.*, 1933.—In this preliminary attempt to form a more satisfactory system of classification than has yet been proposed, 79 planetary nebulæ are divided into six groups : (1) Four of irregular form consisting of two or three very bright condensations, and with broadened irregular spectral lines. (2) Eleven with a bright ring, or two rings, superposed on a fainter uniform disc, and spectral lines distorted, usually split. (3) Twenty-five of disc-like form with clear-cut edges, apparently small and bright, with central star faint or invisible, lines undistorted but sometimes inclined, suggesting rotation of the nebula. (4) Eight of the so-called stellar nebulæ. (5) Twenty-eight of large apparent size but low surface brightness, with conspicuous central star. (6) The three " hydrogen nebulæ," with bright Wolf-Rayet central star. Those of groups (1) and (2) probably represent a transitional stage, and if any have reached mechanical equilibrium it is those of group (3). Judging by apparent galactic concentration, those in group (5) are on the whole the nearest to us. M. A. E.

PLANETS.

4797. Saturn. E. Schoenberg. *Naturwiss.* 21. *pp.* 690–692, *Sept.* 22, 1933.—An account of the German (only) observations of the bright spot of August, 1933, with a summary of previous observations. The author shows that on photometric grounds the outer rings of Saturn consist of fine dust, the inner (dusky) ring of much larger meteoric bodies. Infrequent collisions of these bodies would lead to spiral falls into the upper atmosphere ; the highest clouds would be cut spirally by the falling meteor, whence the longitudinal extension of the spot would be accounted for, as well as its equatorial location and differences from the characteristic spots of Jupiter. T. L. M.

4798. Probable Number of Asteroids within Range of Discovery. B. Jekhowsky. *Comptes Rendus*, 197. *pp.* 579–582, *Sept.* 4, 1933.—From an examination of the apparent magnitudes and the mean distances from the sun of the 1233 asteroids now known, the author estimates that the total number which could be discovered with the means now available is about 2300. M. A. E.

STARS.

4799. Distribution in Space of Draper Catalogue A Type Stars. K. G. Malmquist and L. Hufnagel. *Astron. Iakttagelser Undersökning, Stockholms Obs.* 11. 9. [49 *pp.*], 1933. *In English.*—Two variations (I and II) of Malmquist's original method are used, and the necessary formulæ given. The densities between 50 and 150 *ps* are derived for each of Charlier's 48 galactic zones, giving a central density of 0·34 stars per 1000 ps^3; several stellar condensations are found, and the distances derived for these agree well with other determinations. Since A stars tend to cluster near the galaxy, a more minute division is made of this region. There are comparatively few stars within 50 parsecs of the sun, and the mean density within 10 parsecs, for the Ao A5 stars, yielded 1·43 stars per 1000 ps^3. The discrepancy of this density from that derived from trigonometrical parallaxes is compensated by a correction of $+0^m{\cdot}6$ in the mean absolute magnitudes, and this same correction reconciles the authors' results with those of the Upsala investigators who used Lindblad's short stellar spectra luminosity classification. In the galactic layer, the density distribution varies with galactic longitude, and for regions of low density the question arises between its reality or the effect of absorbing nebulosity. The latter is indicated for at least four regions, the obscuring nebulosities being estimated at about 100 *ps*. Some of the irregularities may be due to traces of a spiral structure. No decision is come to concerning the existence of a local system, seeing that the space considered covers 150 parsecs only. [See Abstract 2242 (1925).] A. S. D. M.

4800. Magnitude Definitions in Astronomical Photometry. P. Rossier. *Arch. des Sciences*, 15. *pp.* 313–323, *July–Aug.*, 1933.—Theoretical work on stellar photometric measures requires knowledge of the curve of sensitivity $\sigma(\lambda)$ of the measuring apparatus. The following hypothesis is regarded as adequate: $\sigma(\lambda) = [(\lambda_1/\lambda)e^{1-\lambda_1/\lambda}]^n$. The following quantities can then be defined and computed as functions of the temperature: the star magnitude m, and magnitudes for fixed wave-length at the maximum of sensitivity μ_s, maximum of radiated energy μ_r, and maximum of apparent energy μ_a. μ_r behaves very differently from the others; none are equivalent, especially for apparatus without a clearly defined maximum of sensitivity; and for μ_a differences may reach several magnitudes. This variation suggests explanations (at least qualitative) of some anomalies in stellar statistics. T. L. M.

4801. Star Streams in the Neighbourhood of 13h. R.A. and + 52° Dec. A. Bemporad. *Accad. Lincei, Atti*, 17. *pp.* 1025–1031, *June* 18, 1933.—The proper motions found for stars in this region yield results which agree well as concerns direction of streaming with those given in two earlier papers [see Abstract 4397 (1933)]. M. A. E.

4802. Interstellar Absorption. A. Colacevich. *Accad. Lincei, Atti*, 17. *pp.* 1065–1069, *June* 18, 1933.—The presence of matter in interstellar space is evidenced by (1) redward coloration of the stars, resulting from absorption, which is the greater the smaller the wave-length ; and (2) by the appearance of Ca and Na (particularly of Ca) dark lines in the stellar spectra. The author studies their phenomena, and their relations to the stellar distances, on the basis of the astronomical catalogues, and suggests that this may result in a method for measuring star-distances. A. D.

4803. Schwarzschild's Problem of the Gaseous Sphere. N. R. Sen and N. K. Chatterjee. *Zeits. f. Astrophysik*, 7. *pp.* 188–207, *Sept.* 16, 1933. *In English.*—The equations of general relativity for the cases of spherical polytropic masses of gas of indices **3** and **3/2**, respectively, are solved by numerical integration. The results for spheres with central densities up to 10^6 gm./c.c. do not differ appreciably from those of the ordinary theory. If central densities of the order of 10^{12} gm./c.c. are assumed, it follows that the relativity spheres are less massive than the corresponding non-relativity Emden spheres, but there is a tendency in the former for the mass to accumulate near the centre leaving the remoter regions poorer in mass. G. C. McV.

4804. Interpretation of the Hertzsprung-Russell Diagram. B. Strömgren. *Zeits. f. Astrophysik*, 7. *pp.* 222–248, *Sept.* 16, 1933. *In English.*—It is known that the astronomical value of the coefficient of opacity of a perfect gas can be brought into accord with the value calculated from physical theory if the star is supposed to have a sufficient admixture of hydrogen and to be composed of perfect gas throughout. The hydrogen content for forty stars is computed by a method already given [see Abstract 3201 (1932)]. It is found that for most stars the hydrogen content is determinate, but for some of large mass and large hydrogen content, the latter is practically indeterminate. It is deduced that the position of a star on the Hertzsprung-Russell diagram is determined by its mass and its hydrogen content. This leads to the conclusion that the stars cannot evolve on the short time-scale : the hydrogen content might change during times of the order of the intermediate time-scale but the mass requires the long-time scale in order to alter appreciably. Various other features of the distribution of stars on the diagram are also considered. G. C. McV.

4805. Perturbations in the System of Sirius. C. Volet. *Bull. Astronomique*, 8. 1. *pp.* 51–64, 1932.—The author analyses the residuals of the motion of Sirius B as found in a previous paper [see Abstract 2785 (1932)]. He finds a perturbation of period 6·4 years, amplitude $0''\cdot14$; if attributed to a satellite of B, Sirius C, its motion would be direct, eccentricity small, plane that of B, mean distance about $1''\cdot2$, mass 1/16 B. These conclusions resemble those of Zagar closely. The resulting ephemeris is not inconsistent with the supposed observations of a satellite of B already made. T. L. M.

4806. Orbit of Spectroscopic Double Star, τ Persei. L. Gialanella. *Accad. Lincei, Atti*, 17. *pp.* 940–944, *June* 2, 1933.—On the basis of 21 measurements of radial velocities effected at the Lick Observatory, the author computes the elliptical elements of the orbit of τ Persei [see Abstract 3972 (1933)]. A. D.

SUN.

4807. Regularities in the Succession of Solar Phenomena. H. Deslandres. *Comptes Rendus,* 197. *pp.* 589–593, *Sept.* 11, 1933.—The author's work suggests that the intervals between large magnetic storms correspond to multiples of 30° of solar rotation. He now shows that for a number of solar rotations faculæ occur at longitude intervals which are also multiples of 30°. The intervals are actually a little less for faculæ in low latitudes, a little more for high latitudes ; corresponding to the varying rotation period. A table of typical distributions is given. This regular division into regions of activity is natural to a homogeneous spherical layer submitted to increasing internal pressure, here presumed to be radioactive emission. T. L. M.

4808. Measurement of Radiation in the Solar Vertical. R. Knepple. *Gerlands Beitr. z. Geophys.* 39. 4. *pp.* 378–398, 1933.—Using the actinometer employed by Meyer for similar horizontal measurements [see Abstract 2892 (1933)], modified by the possibility of inserting a quartz plate so as to cut off all radiation of $\lambda > 3\mu$, " vertical " measurements have been made with and without insertion of the quartz plate, those with the plate giving the " clear," those without, the " total " radiation, the difference being the " dark " radiation which is shown to be practically identical with that of the night sky and independent of the sun's position. The opening of the actinometer was moved in a great circle from horizontal on one side to direct towards the sun and then to horizontal towards the other side of the sky. Positive values were obtained always for the clear radiation, and for the total for elevations not above 30°, negative for higher elevations of the total, and always for the dark radiation. Results with a cloudy sky are discussed, and dependence of sky radiation on the turbidity factor upheld. An equation for the intensity of solar radiation at the earth's surface is deduced, and results obtained shown to agree closely with King's theory. [See also Abstract 61 (1931).] C. A. S.

GEOPHYSICS.

GEODESY.

4809. Figure of the Earth. H. Jeffreys. *Gerlands Beitr. z, Geophys.* 39. 4. *pp.* 374–377, 1933. *In English.*—A reply to Hopfner's criticisms of the author's support of Heiskanen's views regarding the ellipticity of the equator is given, and the conclusion is upheld that Heiskanen's determination of the figure of the earth as far as the second harmonics is the best yet made. [See Abstracts 2995 (1931) and 2881 (1933).] C. A. S.

4810. Integral Equation of Physical Geodesy. N. Idelson. *Gerlands. Beitr. z. Geophys.* 40. 1. *pp.* 24–28, 1933.—Reference is made to an earlier paper [see Abstract 2606 (1931)] in which it was shown that the solution of the main problem of physical geodesy could be reduced to a boundary value problem of the potential theory. This, however, is equivalent to an integral equation. In the paper this equation is established and it is solved with the help of a Neumann series. R. S. R.

4811. Nets of Triangles Consisting of Points with Circular Error-Curves. J. M. Tienstra. *K. Akad. Amsterdam, Proc.* 36. 6. *pp.* 656–665, 1933.—When by measurement the position of a point in a plane has been determined the accuracy of this determination is represented by the error-curve of the point according to the theory of least squares. This curve is a foot-point curve of an ellipse. The determined point is the centre of this curve. In particular cases the error-curve is a circle. The point is then determined with the same accuracy in all directions. It is generally best to require equal accuracy in all directions when determining a point, and this is the case with an angle point of a net of triangles. In the paper the author proves mathematically that if the angles of a net of triangles, without obtuse angles, are measured with weights which are per triangle proportional to the cotangents of the angles, all the points of the net will have circular error-curves. No account is taken of the influence on the accuracy of the position of the points as a consequence of errors of observation in the measurement of the base.
R. S. R.

4812. Continental Undulations of the Geoid. R. A. Hirvonen. *Gerlands Beitr. z. Geophys.* 40. 1. *pp.* 18–23, 1933.—The author employs Heiskanen's assumption and seeks to determine whether undulations of the geoid, at least in regions where sufficient observations exist, could be estimated with sufficient certainty if the gravity field is extended by extrapolation and hypotheses are used to complete it. Many recent determinations of gravity are used for different parts of the earth comprising 32 % of the northern and 4 % of the southern hemisphere. These are expanded by extrapolation and interpolation. In a table are then set out for each 10° of longitude and several values of latitude the mean values of gravity anomaly, and the calculated geoid distance (N). These give values of N with a mean amount of ± 50 m. and a range of ± 80 to 85 m. except for one case which exceeds 100 m. The calculations of geoid distance are based on Stokes's formula. The results are to be discussed in detail in a later paper. R. S. R.

4813. Geodetic Operations in the United States, January 1, 1930, to December 31, 1932. W. Bowie. *Coast and Geodetic Survey, Special Publication No.* 178, 1933.

See also Abstract 4815.

GEOPHYSICS, APPLIED.

4814. Electrical Resistivity for a Region Underlying Two Uniform Layers. I. Roman. *Terr. Mag.* 38. *pp.* 117–140, *June, and pp.* 185–202, *Sept.*, 1933.—As an extension of a previous paper [see Abstract 758 (1932)], the potential distribution due to a point source of current, in one of four media of differing conductivity, is examined. The media are separated by a series of parallel planes. The results are applied to the practical three layer problem, which occurs in prospecting, by making one conductivity zero and placing the current source at the free surface. The results are in agreement with solutions of the same problem obtained by other workers using somewhat different methods of approach. J. M. B.

4815. Rapid Adjustment of Observations in Network of Geophysical Stations by the Method of Least Squares. E. Lancaster-Jones. *Phys. Soc., Proc.* 45. *pp.* 792–807, *Nov.* 1, 1933.—A frequent problem in geodesy and geophysics concerns the adjustment of a set of values for a physical magnitude at a number of stations. The values are obtained from other observed magnitudes by computations involving the geometrical links of the station network, and there is ambiguity on account of the multiplicity of connections. Since the magnitude desired is single-valued at each station, the values obtained are usually adjusted by the method of least squares. Where the number of stations is large and the network is complex, the normal equations for least-square adjustment are very numerous and their solution by standard procedure is tedious. The paper develops a method of establishing the normal equations, and solving them by successive approximations, which is simple, rapid and satisfactory in practice, and is applicable to any network, however large and complex. Although particular attention is focused on the problem of obtaining isogams from observations of gravity gradients in applied geophysics, the method has obvious applications in other fields where the mathematical conditions are similar. AUTHOR.

HYDROSPHERE, PHYSICS OF THE.

4816. Light Penetration in the Waters of the San Juan Archipelago. C. L. Utterback and J. W. Boyle. *J.O.S.A.* 23. *pp.* 333–338, *Oct.*, 1933.—Measurements of the penetration of visible solar radiation into the waters of the San Juan Archipelago have been made at several stations, and absorption coefficients computed from the measurements. The data reported include three spectral bands: one from 6000 to 7000 Å with nearly constant transmission throughout this band; the second from 5000 to 5900 Å with a definite maximum at 5400 Å; and a third from 4100 to 5000 Å with a maximum of 4650 Å. The illumination beneath the surface was measured with a calibrated photronic cell thus giving quantitative comparison of the intensities of different parts of the spectrum at different depths. In some cases the variation was exponential but not in all. Evidence of microscopic life on the penetration of light is indicated. The illumination has been measured to depth of 50 m. in the inshore waters. [See following Abstract.] AUTHORS.

4817. Light Penetration in the Waters of Southern Alaska. C. L. Utterback. *J.O.S.A.* 23. *pp.* 339–341, *Oct.*, 1933.—Continuing previous work [see preceding Abstract] the interesting new feature of the waters of Southern Alaska is definite evidence of layering. In addition to photosynthetic action it is probable that this is caused, in part at least, by the discharge of rivers and by glacial effects. AUTHOR.

LAND, PHYSICS OF THE.

4818. Velocity of Elastic Waves in Granite and Norite. L. D. Leet. *Physics*, 4. *pp.* 375–385, *Oct.*, 1933.—Determined by means of dynamite explosions over distances up to 6260 ft. in granite (*d* 2·63), at Rockport (Mass.), and 10,320 ft. in norite (*d*, 2·85), at Sudbury (Ont.), the velocities of longitudinal, transverse, and Rayleigh waves were respectively 5·14, 2·70 and 2·19 km./sec. in granite, and 6·22, 3·49 and 2·79 km./sec. in norite. From these results were deduced the rigidity 19·2 and 34·7 × 10^{10}, bulk modulus 44 and 64 × 10^{10}, Young's modulus 50 and 88·2 × 10^{10} dynes/cm^2., compressibility 2·28 and 1·56 × 10^{-12}, and Poisson's ratio 0·31 and 0·27 respectively. The results as regards compressibility confirm Zisman's conclusions [see Abstracts 2763 (1932) and 4420 (1933)]. The results for different rocks show that no safe inference as to the nature of the rock traversed can be drawn from the velocities of seismic waves. C. A. S.

4819. Pressure Exerted by Granular or Pulverulent Material. Z. Anzo. *Kyushu Univ. Faculty of Eng., Mem.* 7. *pp.* 89–143, *July*, 1933. *In English.*—The stress distribution in a mass of material is determined by a method based on the assumption that the material is an elastic body in equilibrium under granular friction, but not susceptible to tension, a stress function of a form such as $\chi = \gamma\,[Ax^3/6 + Bx^2y/2 + Cxy^2/2 + Dy^3/6]$ being employed in conjunction with the conditions of the particular shape of pile considered. The stress distribution in a sand pile of triangular cross-section is determined by dividing the central "influenced region" of the pile (where the pressure at the base does not vary linearly with horizontal distance) into a series of elementary wedges from the apex, the constants of the stress-functions for the wedges being determined by a set of simultaneous equations expressing the equilibrium conditions. The known formulæ of Rankine, Coulomb and Boussinesq for the pressure on a retaining wall are obtained from a stress-function, but a more accurate solution is proposed by the application of the elementary wedge method to the "influenced region" close to the wall. The results calculated were found to be in good agreement with the experimental results of Darwin and Jenkin. The surface of rupture is also calculated and found to be curved in the "influenced region" with a straight continuation outside it. Experiments with layers of sand of distinctive colours in a glass-sided container having a displaceable end gave general agreement with the theoretical results. R. F. A.

METEOROLOGY.

4820. Transformations of Energy in the Atmosphere. D. Brunt. *Roy. Meteorolog. Soc., J.* 59. *pp.* 343–349, *Oct.*, 1933.—In this paper the author, after dealing with the incoming radiant energy from the sun and the portion of it absorbed by the earth and its atmosphere and so made available for transformation, discusses the classification of available energy under the heads, kinetic, turbulent, gravitational potential, and thermal. The processes of transformation of these different types from one to another is dealt with. Consideration is given to the problems of the development of circulations between sources of heat and cold with special reference to Sandström's work, and of the energy liberated by vertical interchanges of mass. In connection with the latter, the work of Margules is discussed at length and is shown to be incomplete in some respects.

A. E. M. G.

4821. Adiabatic Lapse-Rate for Dry and Saturated Air. D. Brunt. *Roy. Meteorolog. Soc., J.* 59. *pp.* 351–359; *Disc.,* 359–360, *Oct.,* 1933.—This paper is to a great extent mathematical. Having obtained an expression for the lapse-rate for dry air the author proceeds to obtain a corresponding expression for saturated air when displaced slightly from its equilibrium position. This expression is then modified, by omitting from it the component due to the vapour pressure of water, a quantity negligible in comparison with the atmospheric pressure. This permits of a ratio between the saturated lapse rate and the dry adiabatic being obtained depending only on the temperature and pressure which admits of comparatively easy computation. A table is compiled giving the various components in this relation, for the range 200 Å to 320 Å. The dependence of the lapse-rate on temperature and pressure is illustrated graphically. On account of the importance of the fundamental equation for rising saturated air, an alternative derivation of this equation is given which by assuming the principle of entropy reduces the derivation to briefer compass. A short discussion follows. A. E. M. G.

4822. Calculation of Meridional Exchange-Coefficients. H. Lettau. *Gerlands Beitr. z. Geophys.* 39. 4. *pp.* 426–430, 1933.—A more satisfactory method of deducing the effective radius of a rotating mass of air from the meridional exchange coefficient is described, and a method, with example, of deducing this coefficient from the pressure distribution is given.

C. A. S.

4823. Development of Gradient Winds. H. Arakawa. *Geophys. Mag. Tokyo,* 7. *pp.* 165–169, *Aug.,* 1933. *In English.*—This is a mathematical paper in which the author does not confine himself to the investigation of the steady state, but discusses the development of the gradient wind. If v_x and v_y be the components of the wind velocity, then by putting $v_x + iv_y = V$, he obtains from the equations of motion a single equation for V. Pressure gradient being assumed constant, this equation has a solution of the form $V = V_1 + V_2$, where V_1 is a function of z (the height) and V_2 a function of both z and t. At $z = O$, V_2 decays gradually, and the current approaches a steady state, the nearer the surface the shorter the time required. Assuming perfect slipping, the solution, at $z = O$, is of the form $V = V_g\{1 - e^{-il.(t+e)}.\}$ *i.e.* the velocity consists of two parts, one uniform the other periodic. If v_x and v_y, the components of V, be integrated over a long period T, the integral in each case being divided by T, then it follows that the x-component tends to V_g, the other to zero. Hence a uniform pressure gradient causes a mean flow V_g perpendicular to its own direction. A. E. M. G.

4824. Variations in the Structure of Wind over Different Surfaces. C. S. Durst. *Roy. Meteorolog. Soc., J.* 59. *pp.* 361–371; *Disc.,* 371–372, *Oct.,* 1933.—In this the author in an endeavour to find out how eddy motion is affected by differences in surfaces over which the wind flows examines a number of anemograms from stations of different exposure. (*a*) open agricultural land, (*b*) open to the sea, (*c*) desert exposure, (*d*) town exposure. Four types of anemograms are considered. From the examination it is found that over the sea coast the short period fluctuations are greater in tropical air than in polar air: also that smooth flowing air which characterises one of the anemogram types and occurs with inversions can persist with higher velocity over the sea than over agricultural land. In the free air over the latter the structure of gust fronts is more clearly marked than at heights within 50 ft. of the surface. The examination of records from (*c*) and (*d*) affords an example of the structure of wind over a desert and the frictional churning of the air due to a town. This latter effect is found to have an appreciable influence on the temperature. In the discussion, attention is directed particularly to the structure of the wind over desert country and to the effect of the frictional churning on the temperature. A. E. M. G.

4825. Variations of Wind Direction in the British Isles since 1341. C. E. P. Brooks and Theresa M. Hunt. *Roy. Meteorolog. Soc., J.* 59. *pp.* 375–387; *Disc.*, 387–388, *Oct.*, 1933.—Tables are compiled from various records of the three centres, London, Edinburgh and Dublin giving the average wind direction and the "constancy" at each station for the summer period, for the winter period and for the whole year for each year onwards from 1667 for London, 1731 for Edinburgh, and 1725 for Dublin. The main features of these tables are discussed as *e.g.* the general persistence of S.W. winds. Some periods while showing a preponderance of easterly winds in London do not show the same in the Edinburgh records. Previous to 1671 no systematic observations of wind direction are available but from a few isolated items the authors are able to give some general idea of conditions from 1341 onwards. Among the features of the paper dealt with in the discussion there is one in particular where it is seen that those years which from other investigations show low temperature records are just the years in which the paper indicates winds with an easterly component. A. E. M. G.

4826. Removal of Heavier Air on a Sloping Surface and Theory of Stationary Air Currents. A. Defant. *Preuss. Akad. Wiss. Berlin, Ber.* 18. *pp.* 624–635, 1933.—The paper deals in a general way with katabatic winds. Reference is made to earlier reports on their occurrence and especially to the investigations of Hobbs on winds in Greenland and those of Wegener for Spitzbergen. The author considers that the gravitational flow of cooled surface air is not sufficient to account for all the facts because under certain circumstances the air flow may be up a slope. The equations of motion are established in which gravity alone is first considered and next the frictional effect at the surface is introduced, but the effect of the earth's rotation is neglected. The conditions for stability are established and depend upon the relative values of the slope of the surface and the coefficient of friction (μ). Instability begins and turbulent flow commences, and is propagated outwards exponentially, when the angle of slope $> 4\mu$ or approximately 1/100. For smaller angles the flow of air is non-turbulent. This is the case for the main ice cap of Greenland with a slope of 1/200. In Kamarujukfjord the slope becomes 1/7 and the flow of air to the sea is highly turbulent. The results are found to be in complete agreement with the observed facts for Greenland expeditions and they apply also to föhn winds in the Innsbruck valley and to the bora. R. S. R.

4827. Clouds and Cells. G. T. Walker. *Roy. Meteorolog. Soc., J.* 59. *pp.* 389–396, *Oct.*, 1933.—The author discusses a scheme of air motion in the form of cells in the atmosphere, in which the up currents pass along the axis and the down currents along the outsides. Clouds are the products of this motion. The cells do not appear, however, to be confined to the cloud layer above but to extend considerably below it. Much information on this point is given in the Cardington Memoir. [See Abstract 3608 (1932).] Of the two main groups of disturbance there considered the one of large diameter due to convection is divided into two types. The cells of type I, associated with squalls in thundery weather, are found to have a diameter from 10 to 30 km. with cyclonic circulation. Also if the eddy winds characteristic of type II be treated as due to the passage of circular cells these are seen to be about 270 m. in diameter, and the plotting of the simultaneous winds at four stations supports this view. The work of Scrase and Möller on wind structure is next considered and the deductions from it applied to explain the cloud type with pendant fibres. The paper is illustrated by several cloud photographs and diagrams. A. E. M. G.

4828. Dew Point Hygrometer. S. R. Williams. *Rev. Sci. Instruments,* 4. *pp.* 549–550, *Oct.*, 1933.—Because of difficulties in securing consistent results with the Alluard form of dew point hygrometer, a new form has been suggested. The important features of the new form are the small heat capacity of the dew forming surface, a polished concave surface in which the spot of dew forms and the application of a thermocouple to the measurement of the temperature at which the dew forms. AUTHOR.

See also Abstracts 4794, 4836, 4954, 4971.

SEISMOLOGY.

4829. Propagation of Elastic Waves over the Plane Surface of a Semi-Infinite Body. T. Sakai. *Phys. Math. Soc., Japan, Proc.* 15. *pp.* 291–327, *Aug.*, 1933. *In English.*—Assuming a dilatational disturbance at a point (the focus) below the plane surface of a semi-infinite isotropic, homogeneous, elastic body, R, r being the distances of the point on the surface under consideration from the focus and epicentre respectively, and d the depth of the focus, it is shown that near the epicentre there is only a P wave of amplitude proportional to 1/R ; but far therefrom there are also Rayleigh and S waves, of amplitudes proportional to $1/\sqrt{r}$ and $1/r^2$ respectively, while that of P is proportional to 1/R when d is large compared with the wave-length, but small compared with r, but to $1/r^2$ when d is small. In the intervening region it can only be stated that Rayleigh and S waves do not appear unless r is $> v_3 d/\sqrt{v_1^2-v_3^2}$, and $v_2 d/\sqrt{v_1^2-v_2^2}$ respectively (v_1, v_2, v_3 being the velocities of propagation of P, S, and Rayleigh waves respectively). Profiles of wave forms are given. [See Abstract 27 (1926).] C. A. S.

4830. Propagation of Elastic Waves in a Heterogeneous Medium and the Validity of the Ray Theory. H. Arakawa. *Geophys. Mag. Tokyo,* 7. *pp.* 155–160, *Aug.*, 1933. *In English.*—The ray theory, deduced from Fermat's principle of least time, has been commonly used in the study of the transmission of elastic waves in the earth's crust. The ray theory is found to be valid for the propagation of waves in the deep interior of the earth, but it fails for the propagation of waves in the upper part of the crust, especially for the surface layer down to a depth of 20 km. W. A. R.

See also Abstract 4818.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

4831. Correction of Previous Results on Nucleus Counting and Ionic Charge. H. Israël. *Gerlands Beitr. z. Geophys.* 40. 1. *pp.* 29–43, 1933.—All the dust-counts given previously by the author are too high by a division-mistake of the Aitkens' pocket dust-counter. The necessary corrections are made. The relation of charged to uncharged nuclei in the atmosphere is discussed and it is shown that the discrepancies, connected intimately with the dust-counts, are real and easily explained, if it is assumed that some of the large ions carry more than one electronic charge. It is probable that an increase in the relative humidity favours the taking up of more than one electronic charge. F. C. C.

4832. Life of Ions in Free Air. J. Scholz. *Gerlands Beitr. z. Geophys.* 40. 1. *pp.* 61–74, 1933.—In Westerland, Schweidler's method is used to determine the length of life ζ of small ions and simultaneously, by a new nucleus counter, the amount of ionisation q is found. The results show: (1) visibility and number of ions are interdependent; (2) the ratio of unladen to laden nuclei is 3·4 for land winds and 1·1 for sea breezes; (3) the mean value of the amount of ionisation $q = 6\cdot 0 \pm 1$ J/cm^3.sec., and the mean length of the ion's life $= 15\cdot 4 \pm 7\cdot 7$ sec. Laboratory experiments are carried out to correct errors introduced by Schweidler's method. One source of error is due to disturbances formed by decay of ions during the experiments. H. M. B.

4833. Rôle of Space-Charge in Atmospheric Electricity. J. G. Brown. *Terr. Mag.* 38. *pp.* 161–173, *Sept.*, 1933.—In this paper the author, after referring to the theoretical methods employed by Schweidler and others to solve the problem of the distribution of positive space-charge in the atmosphere, shows how he has approached the problem by experimental methods. Continuous measurements of space-charge and potential gradient have been made for some time at or near Stanford University, California, and from these observations tables have been compiled giving the mean values of the quantities for each month for every hour of the day. The air examined was drawn from two levels, the first 1 m. above the ground, the second 15 m. The results are plotted and the diurnal variations discussed. The author considers that turbulence can account for this diurnal variation of the space-charge near the surface, other factors being of secondary importance. The effect of conductivity on the space-charge is also discussed, in particular the influence of fog layers, while reference is also made to the part played by the variation of the amount of radon and thoron present in the atmosphere arising from "surface breathing." The author concludes "that the variations in the earth's field at land stations can be accounted for by the formation and distribution of space-charges in the atmosphere." A. E. M. G.

4834. Possible Stellar Origin of High-Speed Ions. R. Gunn. *Terr. Mag.* 38. *pp.* 247–256, *Sept.*, 1933.—The presence of "fixed" clouds of ionised calcium implies that all interstellar space is approximately free from electric fields and free electric charges. High-speed ions cannot therefore be produced in interstellar space by electrical means. It is shown that within a sunspot, however, conditions are such that a negative ion can traverse the solar atmosphere and acquire energy comparable to the potential difference between the sun and its higher atmosphere. Such an electron or negative ion attracts to itself, from the higher atmosphere, a neutralising positive ion and the two ions, forming a neutral pair, leave the sun with the same velocity. The energy of the neutral stream is, however, a very small fraction of the energy radiated by the sunspot. The effects of these ions plunging into the earth's atmosphere are considered and it is possible that they produce the aurora. Neutral ion-pairs of solar origin can have no relation to the penetrating radiation because of their low energy, but similar processes in early type stars will give rise to neutral ion-pairs of approximately 10^{10} eV energy. It is suggested that these energetic neutral ion-pairs, which perhaps get separated on entering the earth's magnetic field or by collisions in the earth's atmosphere, are identical with the penetrating radiation. Reasons are given for believing that the distribution of such particles in space is nearly uniform. F. C. C.

4835. Effects of Turbulent Air-Flow in Apparatus for Atmospheric-Electric Measurements. O. H. Gish. *Terr. Mag.* 38. *pp.* 257–259, *Sept.*, 1933. *Phys. Zeits.* 34. *pp.* 712–713, *Sept.* 15, 1933.—Discrepancies in the values obtained by different experimenters [see Graziadei, Abstract 1401 (1933)] for the average mobilities of atmospheric ions are attributed to effects due to turbulent air-flow in the apparatus, since in many of the experiments the Reynolds number was considerably above the lower critical value. A brief theoretical investigation is given. [Graziadei is reported to be conducting further experiments on the subject.] F. C. C.

4836. Aerial-Earth Current. Part III. H. Noto. *Phys. Math. Soc., Japan, Proc.* 15. *pp.* 344–365, *Sept.*, 1933. *In English.*—The author first enumerates the probable sources of the aerial-earth current. Pheonomena relating to changes in this current which can be followed by a galvanometer and an oscillograph are discussed and the results are applied to the actual aerial. It was found that (1) the discharge current is much greater with a positive electric field surrounding the aerial than with a negative one; (2) when values are calculated for the discharge current for aerials of 280 and 15 m. length at heights of 30 and 15 m. respectively, the magnitude is less than that recorded by an oscillograph during lightning discharge; (3) on account of the change of capacity current with diameter of the aerial it is advisable to use an aerial of small diameter to study the field under thunder clouds, because with the signs of the capacity and discharge currents opposite it is better to study the field changes when the latter current is more prominent; (4) the capacity and discharge currents can be distinguished because the former flows for a shorter time while the latter fluctuates with field changes; (5) the discharge current is larger with a strand wire than with a solid wire of the same diameter; since only the capacity current is effective in wireless communication it is better to use a solid wire, and thus the atmospherics in the discharge current are proportionately less disturbing; and (6) rapid field changes under thunder-clouds cannot be recorded by radioactive or waterdrop collectors, because a few minutes are required to indicate the true potential. [See Abstract 4430 (1933).] R. S. R.

4837. Electric Charge Collected by Water Drops falling through Ionised Air in a Vertical Electric Field. J. P. Gott. *Roy. Soc., Proc.* 142. *pp.* 248–268, *Oct.* 2, 1933.—Three series of experiments have been made to determine the charge collected by a water drop falling in a vertical field through air ionised by a beam of X-rays, different forms of ionisation being produced in the three cases. It was found that (1) in the presence of ions of one sign only rising up to meet the falling drop, it collects a charge for all values of the electric field ; (2) when ions of one sign only are moving down in the same direction as the drop falls, the charge collected depends on the velocities of the drop and the ions ; and (3) if the descending ions have the greater velocity, so that they overtake the drop, then it collects a charge, but if the drop has the greater velocity, so that the descending ions cannot overtake it, then it collects no charge. The electric field which gives to the descending ions a velocity equal to that of the drop is the critical field for the phenomenon. In the presence of ions of both signs, carrying equal currents, the drop collects no nett charge in fields greater than the critical field. In fields less than the critical field it collects more ascending than descending ions and so gains a nett charge. This charge does not increase indefinitely, but tends to a limiting value. Experiments have been made with one size of drop only. In fields greater than the critical field, the initial rate at which the drop collects charge in the presence of ions of one sign only is equivalent to collecting the ionisation current from an area equal to three times the area of cross section of the drop. This applies both for ascending and descending ions. In fields less than the critical field, the initial rate at which the drop collects charge from ascending ions appeared, in the experiments, to be different from this value, but the difference may not be a true effect. In the experiments the drop was not distorted from the spherical shape. These experimental results are in accordance with the theory proposed by C. T. R. Wilson to account for the mechanism of thunderstorms and the electric charge brought down by rain. [See Abstract 280 (1930) respectively.] R. S. R.

4838. Norwegian Arctic Expedition in the Gjøa, 1903–1906, under the Conduct of Roald Amundsen. Part II. Terrestrial Magnetism. A. S. Steen, N. Russeltvedt and K. F. Wasserfall. *Geofysiske Publ.* 7 [309 *pp*], 1933.—[For Parts I and III see Abstracts 3178 (1932) and 582 (1931) respectively.]

4839. Relation between Magnetic Activity and the Absolute Values of the Horizontal Component. L. Eblé. *Terr. Mag.* 38. *pp.* 203–205, *Sept.*, 1933. *In French.*—After a magnetic storm, the value of H is low, and it returns slowly to its former value. Hence the mean H on the five international calm days for any month is higher than the general mean for the same month. The differences in H from one day to the next are taken for the three days which precede and the three which follow each international calm day. These are examined in regard to their annual and monthly means, and it is concluded that magnetic calms appear towards the end of a period of increase in H, but a disturbance precedes the sudden drop in H which characterises the perturbations. There is a similar succession of changes in the corresponding diurnal values of H in the southern hemisphere, and an explanation is given in terms of atmospheric electric currents. G. E. A.

See also Abstract 4807.

RADIOACTIVITY.

4840. Purification of Radon. Nella Mortara. *Accad. Lincei, Atti*, 17. *pp.* 1069–1072, *June* 18, 1933.—Describes and studies apparatus for condensing emanation out of the gases containing it by exposing these gases to the temperature of liquid air, after having, by cooling, separated all water-vapour, CO_2, etc., from them. A. D.

4841. Luminescence Method of Determining the Range of α-Particles. Berta Karlik. *Akad. Wiss. Wien, Ber.* 142. 2*a*. 3–4. *pp.* 115–119, 1933.—Measurements of the luminescence produced in ZnS by α-particles by means of a photoelectric cell and a Wulf electrometer showed that the light is proportional to the energy absorbed from the particles if these are homogeneous. A beam of α-particles consisting of several groups gives, when the air distance is varied and this is plotted against photoelectric current, a humped curve made up of several parts, which indicates clearly the number and range of the groups. The method is sensitive and comparatively easy to use. It is essential that the luminescent screen should consist of fine particles of high light efficiency and should have no phosphorescence. [See following Abstract.] J. E.

4842. Range of α-Particles from Actinium and its Products by the Luminescence Method. Berta Karlik and Elisabeth Rona. *Akad. Wiss. Wien, Ber.* 142. 2*a*. 3–4. *pp.* 121–125, 1933.—The method described [see preceding Abstract] is used. From the kinks in the curve obtained when the effective air distance is plotted against the photoelectric current the ranges are extrapolated. The results are in good agreement with those obtained by other workers. J. E.

4843. Analysis of Long Range α-Particles from Radium C′ by the Magnetic Focussing Method. (Lord) Rutherford, W. B. Lewis and B. V. Bowden. *Roy. Soc., Proc.* 142. *pp.* 347–361, *Oct.* 2, 1933.—The velocities of the long range groups of α-particles from radium C′ have been measured with accuracy by the annular ring magnet previously described. The α-ray spectrum has been analysed into 11 distinct groups, which have thus been separated for the first time. The corresponding energy levels of the excited nucleus have been deduced with certainty. All the prominent γ-rays may be correlated with these levels if four other levels which do not correspond with observed α-particle groups are postulated. The relative intensities of the α-ray groups and the γ-rays show marked variations, which suggests the importance of dividing the γ-rays into the two types dipole and quadripole, and quantum numbers have been tentatively assigned to the levels. AUTHORS

4844. Energy of β-Rays and Law of Conservation of Energy. M. Hayakawa. *Phys. Math. Soc. Japan, Proc.* 15. *pp.* 328–330, *Aug.*, 1933. *In English.*—The apparent inconsistency with the law of conservation of energy resulting from attributing the continuity of the energy of β-rays to that of the energy of nuclear electrons is discussed. It is suggested that the failure to observe the great amount of energy that should be emitted when a proton and an electron combine to form a neutron may be explained by the potential barrier hypothesis; and that the failure of all electrons to jump to a state of least energy is explicable by the absorption of the emitted electromagnetic wave before it can travel outward, owing to its probably following a spiral path defined by $d^2u/d\theta^2 + u = 3mu^2$, where $u = 1/r$, and $r = 3m$ (approximately). [See Abstracts 4389 and 5069 (1932).] C. A. S.

4845. Scattering of γ-Rays in Air and Water. W. J. Rees and L. H. Clark. *Phil. Mag.* 16. *pp.* 691–703, *Sept.*, 1933.—Radiation from radon sources up to 0·53 curie, enclosed in Pb 0·3 cm. thick and placed in a brass cup, fell on an electroscope enclosed in 0·006 cm. thick Al + 0·025 cm. of celluloid, after passing through 93 cm. of air or (93–x) cm. air + x cm. of water (x varying from 0–20 cm. to the top, and 0–24 cm. to the bottom of the electroscope container), with arrangements for interposing additional 10 cm. Pb between the radon source and electroscope and for surrounding the electroscope with filters of Al or Cu 0·006–2·9 cm. thick, so as to cut off primary radiation. It is shown that γ-rays scattered in air are very heterogeneous, many having a penetrating power similar to that of β-rays from Ra(B + C), the softer rays are absorbed equally by equivalent thicknesses of Al and Cu, the harder more easily by Cu. γ-Rays scattered by water include some absorbed in 3–4 mm. of Al, whilst the harder constituents are also more easily absorbed by Cu. The effective wave-length of the more penetrating scattered radiation for both air and water is 0·08–0·10 Å, giving as shift on scattering 0·063 Å, and so suggesting that much of the radiation has been scattered more than once [see Abstracts 2217 (1929) and 3953 (1932)]. C. A. S.

4846. Internal Conversion of γ-Rays. Part II. H. M. Taylor and N. F. Mott. *Roy. Soc., Proc.* 142. *pp.* 215–236, *Oct.* 2, 1933.—It is shown that, if a γ-ray escaping from a nucleus be represented by an electromagnetic wave, then the reduction of intensity suffered by this wave in passing through the K ring is not equal to the number of electrons ejected, and is in general small, even when the number of electrons ejected is comparable with the number of γ-ray quanta emitted. It is shown that the quantity calculated by Hulme, and by Taylor and Mott [see Abstract 991 (1933)] should be interpreted as being nearly equal to the ratio, b/g, of electrons to γ-quanta which is observed, not to the "internal conversion coefficient" $b/(g + b)$, as there stated. The agreement with experiment in the radium B region is slightly less good than before; for radium C the alteration is negligible. AUTHORS.

4847. Effect of Internal Conversion. J. Solomon. *Comptes Rendus*, 197. *pp.* 670–672, *Oct.* 2, 1933.—The views of the author regarding the electronic transitions accompanying internal conversion [see Abstract 4444 (1933)] imply (*inter alia*) that a γ-ray of energy $2 \cdot 852 \times 10^6$ e.V. should be emitted in the case of radiation from RaC + C′, but no trace of such was found. This favours Dirac's theory [see Abstract 2416 (1930)] and the results of Hulme and Sauter [see Abstracts 1361 and 1364 (1932)]. C. A. S.

4848. Disintegration of Lead by Secondary Effects Produced by Penetrating Radiation. B. Rossi. *Accad. Lincei, Atti*, 17. *pp.* 1073–1077, *June* 18, 1933.—Using a non-collinear arrangement of 3 Geiger counters, the variation in the number of triple coincidences, resulting from "showers" of corpuscles, with varying thicknesses of a lead screen placed above the counters, is recorded. The results are in agreement with those of Blackett and Occhialini using an expansion chamber. The rapid diminution of the frequency of the coincidences as the thickness of the lead is increased beyond 2 cm. indicates that the nuclear disintegrations are not caused directly by the penetrating radiation. The nature and origin of the radiation causing the nuclear disintegrations is discussed. F. C. C.

4849. Atomic Disintegration by Penetrating Radiation. J. Barnóthy. *Zeits. f. Physik,* 85. 3–4. *pp.* 201–209, *Sept.* 4, 1933.—Consideration of the Hoffmann collisions leads to the result that the effective collision cross-section for protons, calculated simply from Möller's formula, does not agree with experimental results. With the help of a hypothetical nuclear model, however, of radius 2½ times smaller than the quantum-mechanical radius, the Hoffmann collisions can be explained. On the basis of this model it follows that the most frequent collision results in the ejection of 3 or 4 α-particles (or 12 or 16 protons) ; the maximum effect is produced when all the particles are ejected from a nucleus in the wall-material of the ionisation chamber and pass through the latter simultaneously. In contrast to hitherto accepted ideas, the value of the primary energy of the penetrating radiation as deduced from absorption and magnetic deflection measurements is shown to be sufficient to account for the Hoffmann collisions. [See following Abstract.] F. C. C.

4850. Hoffmann Collisions and Barnóthy's Theory. E. G. Steinke. *Zeits. f. Physik,* 85. 3–4. *pp.* 210–211, *Sept.* 4, 1933.—Continued experimental work [see Abstract 2888 (1932)] on the Hoffmann collisions leads to results, some of which support Barnóthy's theory [see preceding Abstract] while others appear to be in disagreement with it. F. C. C.

4851. Atomic Disintegration with Neutron Emission. G. Kirsch and R. Trattner. *Akad. Wiss. Wien, Ber.* 142. 2*a*. 1–2. *pp.* 71–74, 1933.—The authors conclude from the results of experiments carried out with a Wilson-Shimizu chamber that a large number of elements emit neutrons when bombarded by α-rays from polonium. The absorption in lead and aluminium of the radiation from Pd was measured by means of a Geiger counter. The radiation was found to be softer than that of Be. The emission of neutrons by Pt was confirmed by a photographic method. [See following Abstract.] W. E. P.

4852. Atomic Disintegration with Neutron Emission. J. Schintlmeister. *Akad. Wiss. Wien, Ber.* 142. 2*a*. 5–6. *pp.* 197–200, 1933. —The paper describes the investigation by means of a valve electrometer of the emission of neutrons by Pb, Mg, Cu and Ni under the action of α-rays from polonium. The results confirm in a general way the observations of Kirsch and Trattner [see preceding Abstract]. W. E. P.

4853. Neutron Emission from Beryllium and Boron and Atomic Disintegration by Neutrons. F. Rieder. *Akad. Wiss. Wien, Ber.* 142. 2*a*. 3–4. *pp.* 169–173, 1933.—The paper describes an arrangement for stereo-photography using a large Wilson chamber. Photographs of the emission of H-radiation caused by neutrons from Be were obtained. When the expansion chamber was filled with argon no evidence of the disintegration of argon atoms was obtained from 480 expansions. In the case of nitrogen, five certain instances of a disintegration of a nitrogen atom were observed in 180 expansions. W. E. P.

4854. Excitation of Neutron Emission from Beryllium and Boron by α-Rays. W. Slonek. *Akad. Wiss. Wien, Ber.* 142. 2*a*. 5–6. *pp.* 185–196, 1933.—The dependence of the intensity of the neutron emission from Be and B on the primary absorption of the α-rays from a polonium source was investigated by means of a Geiger counter. The polonium was placed at the centre of a hollow semi-circular apparatus, the air pressure in which was varied in order to vary the primary absorption of the α-rays. The excitation curve, in which the number of tertiary protons is plotted against the primary absorption of the α-rays, indicates the presence of eight resonance levels in the Be nucleus. This result is discussed in connection with that of Kirsch and Rieder [see Abstract 2332 (1933)]. The effect of placing lead absorbers in the path of the protons was investigated. No indication of resonance levels in the B nucleus was obtained. This result is compared with that of Curie and Joliot [see Abstract 1840 (1933)]. W. E. P.

4855. Constitution of Neutrons, Positive Electrons, and Photons. Existence of Negative Protons. J. J. Placinteanu. *Comptes Rendus*, 197. *pp.* 549–552, *Aug.* 28, 1933.—Mathematical considerations are applied to the author's theory that the neutron is composed of a proton and an electron of negative kinetic energy [see Abstract 2930 (1933)]. It is shown that the theory leads directly to the conclusion of Curie and Joliot, *viz.*, that the photon is composed of a neutron and a positive electron ; that a photon of high energy content may break down into a positive and a negative electron ; and that a photon of extremely high energy content may yield a proton and a negative proton. The absence of experimental evidence for the existence of the last-named is attributed to the great energy involved. H. F. G.

4856. Neutrons and Nuclear Magnetic Moments. B. Venkatesachar and T. S. Subbaraya. *Zeits. f. Physik*, 85. 3–4. *pp.* 264–267, *Sept.* 4, 1933.—On the assumption that the neutrons in the nucleus have orbital moments and are arranged in shells in a similar manner to the extra-nuclear electrons, it is shown that the magnetic moment of a neutron is half as large as that of a proton. Using this value the magnetic moments of a series of nuclei are calculated and are found to be in agreement with the values calculated by Goudsmit from hyperfine structure data. J. E. K.

4857. Neutrons and Positive Electrons. R. Fürth. *Zeits. f. Physik*, 85. 5–6. *pp.* 294–299, *Sept.* 14, 1933.—Developing his theory of elementary uncertainties the author gives formulæ for the mass and radius of the neutron and the ratio of the masses of the proton and the electron. Values calculated by means of these formulæ show a remarkable agreement with experiment. The bearing of the discovery of positive electrons upon the theory is discussed and it is suggested that a neutron upon colliding with an atomic nucleus may break up into a positive electron and a negative proton. J. E. R. C.

4858. Collisions of Neutrons with Protons. F. N. D. Kurie. *Phys. Rev.* 44. *pp.* 463–467, *Sept.* 15, 1933.—A linear polonium source of about 2 millicuries strength is surrounded by beryllium contained in a brass cylinder coated with a layer of paraffin. This assembly is mounted on the piston in the centre of a large automatic Wilson cloud chamber, in which the tracks due to protons projected from the paraffin layer by the neutrons are photographed. The angle between the proton track and its associated radius is measured. Corrections for scattering volume and effective solid angle of the cloud chamber are applied. On plotting the corrected number of proton tracks against the angle of projection a sharp maximum is found at 0°. The bearing of this distribution on the structure of the neutron is discussed. Author.

4859. Neutrons. J. Perrin. *Comptes Rendus*, 197. *pp.* 628–631, *Sept.* 25, 1933.—The consequences of the view that the neutron, ω, is simple, and the proton, π, consists of a neutron and a positron, *i.e.*, $\omega\beta^+$, are discussed. It is suggested that the demihelion, or hydron, η, is $\omega_2\beta^+$, and not $\pi_2\beta^-$, and the helion consequently $\omega_4\beta_2{}^+$, and formed with loss of 0·050 atomic unit of mass, instead of $\pi_4\beta_2{}^-$, with loss of 0·032. Thus all atomic nuclei consist of $n\omega + m\beta^+$ associated as protons, hydrons, or helions, and containing no free electrons, β^-. Radioactive emission of β-rays would result from simultaneous formation of β^+ and β^- by absorption of a penetrating photon, β^- being expelled, β^+ uniting with a neutron. The loss of mass of stars is explicable by the disappearance of the magnetic field to which the magnetic moment of the neutron is due with production of very penetrating photons (cosmic rays, energy about 10^9 e.V.). Such photons in their passage across a star become less and less penetrating through the Compton effect, ionisation, and production of β^+ and β^-, so that within a star creation of matter is less probable than its disappearance. The contrary result must occur in interstellar space by an inverse Compton effect, though some cosmic rays may be due to disappearance of neutrons present (with ionised or stripped atoms, helions, hydrons and protons) in space. C. A. S.

4860. Artificial Production of Neutrons. H. R. Crane, C. C. Lauritsen and A. Soltan. *Comptes Rendus*, 197. *pp.* 639–641, *Sept.* 25, 1933.—A plate one side of which is brass and the other Be was bombarded by He ions accelerated by 10 mA. at 6–$9 \cdot 75 \times 10^5$ volts, accompanying electrons being deviated magnetically. The resultant radiation (neutrons and γ-rays) was determined in an ionisation chamber (*a*) with the walls covered with paraffin, and (*b*) without them so covered, this rendering the chamber more sensitive to γ-rays and less so to neutrons. The results indicate a rapid increase of neutrons when the voltage exceeds 7×10^5 volts. A tube working with 30 mA. at $9 \cdot 5 \times 10^5$ volts forms a much more intense source of neutrons than Po + Be as usually employed. C. A. S.

4861. Disintegration of Nuclei of Nitrogen and Other Light Atoms by Neutrons. W. D. Harkins, D. M. Gans and H. W. Newson. *Phys. Rev.* **44.** *pp.* 529–537, *Oct.* 1, 1933.—7600 photographs of the results of the action of neutrons from MsTh + Be on nitrogen in a Wilson chamber showed 19 disintegrations in which the neutron was captured: $N^{14} + n \rightarrow N^{15} + He^4$, the maximum number occurring for neutrons of velocity $3 \cdot 2 \times 10^9$ cm./sec., with limits $1 \cdot 9$–$5 \cdot 5 \times 10^9$, and the maximum energy of a neutron at capture being $15 \cdot 8 \times 10^6$ e.V. (theory for an α-particle from ThC′ $14 \cdot 7 \times 10^6$). In all cases of disintegration kinetic energy was conserved or (more usually) disappeared, probably with conversion into γ-rays, as also was the case when mass was converted into energy. In nine cases the neutron was probably first deflected by a nucleus and then disintegrated one with capture, or was not captured. Neon and ethylene similarly treated gave 13 and 2 disintegrations respectively in 3200 photographs each, with disappearance of 5–11×10^6 e.V. A modified form of chamber is described. [See Abstract 4374 (1932).] C. A. S.

4862. The Neutron. J. Chadwick. *Roy. Soc., Proc.* 142. *pp.* 1–25, *Oct.* 2, 1933.—This paper is a general discussion of the properties of neutrons. The production of neutrons by the bombardment of elements, particularly B and Be, is described and experiments upon the excitation function discussed. It is possible from the latter to obtain evidence of resonance levels in the nuclei of these two elements. Hypotheses as to the process of emission of the neutrons and accompanying γ-rays are discussed together with possible constitutions for the nuclei of B and Be. The possibility of a neutral particle with electronic mass is discussed and an endeavour to discover such a particle described. A review of available methods of deducing the mass of the neutron leads to a probable value of 1·0067. With regard to the possible complex structure of a neutron evidence appears to be conflicting and the question is left open. Experiments upon collisions between neutrons and atomic nuclei are described which necessitate a complex neutron for their explanation ; on the other hand, a consideration of the spin argues against this. The paper concludes with a description of artificial disintegration produced by neutron impact and an account of some experiments with positive electrons. J. E. R. C.

4863. Application of ThB, the Radioactive Isotope of Pb, in Metallurgy. G. Tammann and G. Bandel. *Zeits. f. Metallkunde,* 25. *pp.* 153–156, *July, and pp.* 207–209, *Sept.,* 1933.—The paper describes the method of preparing specimens of metals containing ThB and gives the interpretation of the radiographs produced when such specimens are placed on a photographic plate. Such radiographs show that in Pb, Tl and Cd the distribution of ThB is homogeneous, in Mg the ThB is contained in the crystal grains, while in Bi, Su, Sb, Ag, Zu, Cu, Au and Ni it is concentrated in the grain boundaries. The solubility of ThB in the latter group of metals is shown to be exceedingly small. The solubility in Bi, Su, and Ni is compared with that of Pb. Radiographs showing the concentration of ThB in inclusions in Fe, steel and Al are described. The ThB contained in an Al specimen was found to be transferred to the Pb when the Al specimen and the inactive Pb were melted together. Further examples indicate how ThB may be used in connection with problems relating to crystallisation and the structure of rolled metals.
W. E. P.

See also Abstracts 4723, 4864, 4906, 5015, 5061.

RADIATION.

ABSORPTION AND TRANSMISSION.

4864. Colouring and Decolouring of Compressed Rock-Salt. Magdalene Haberfeld. *Akad. Wiss. Wien, Ber.* 142. 2a. 3–4. *pp.* 135–154, 1933.—Experiments designed to find whether the colouring of rock-salt by β-rays and its decolouring by light follow the same regularities for compressed crystals as for uncompressed. It is known that the colouring is due to the removal of an electron from a chlorine ion, this electron neutralising a Na ion ; that places of strain are especially sensitive to the radiations and that compressed crystals consequently show quicker and deeper colouring than uncompressed ; that the colouring increases to a saturation value with continued exposure. A very detailed investigation has been made in these experiments on the absorption coefficients at the two principal bands produced by various exposures to radium of variously compressed rock-salt. A simple relation between the two coefficients is found in terms of the compression : $s(k_1/k_2 - 1)/(1 - s) = 0{\cdot}5$, where s is the degree of compression, k_1, k_2, the coefficients of absorption. It is further found that as with uncompressed salt, at least for small light energies, every electron removed involves the absorption of one quant.
J. E.

4865. Colour Centres in Alkali Halide Crystals. E. Mollwo. *Zeits. f. Physik,* 85. 1–2. *pp.* 56–67, *Aug.* 29, 1933.—Colour centres were formed by heating crystals of the halogen salts of the alkali metals in metal vapours. The influence of temperature on the concentration of the colour centres, and the effect of temperature on the position and form of the optical absorption bands, at temperatures ranging from − 253° C. and the melting point of the crystal, were investigated. The absorption bands of the colour centres for all the cases investigated were in accord with the results expected from the classical dispersion theory. F. J. B.

4866. Optical Properties of Metallic and Crystalline Powders. A. H. Pfund. *J.O.S.A.* 23. *pp.* 375–378, *Oct.,* 1933.—The method of preparing finely divided metallic " blacks " is described and measurements on the transparency of these blacks in the infra-red are presented. The use of sodium and thallium chlorides, distilled as finely divided powders on radiometer vanes, yields a selective receiver, the far infra-red. A new type of transmission band, shown by coarse powders of quartz and calcite, is described. AUTHOR.

See also Abstracts 4747, 4816, 4817, 4893, 4913.

COLORIMETRY.

4867. 1931 I.C.I. Standard Observer and Coordinate System for Colorimetry. D. B. Judd. *J.O.S.A.* 23. *pp.* 359–374, *Oct.,* 1933.—This report makes available in convenient form the properties of the standard observer recently recommended for colorimetric purposes by the International Commission on Illumination. These data supersede the values published in the 1922 report of the committee on colorimetry known as the O.S.A. excitation data. Forms are given for computing trilinear coordinates (trichromatic coefficients), dominant wave-length, colorimetric purity, and luminous transmission (or reflectance) from spectrophotometric data. Tables of the data needed are included for the 1931 I.C.I. standard illuminants *A*, *B* and *C*. AUTHOR.

ELECTRO-OPTICAL AND MAGNETO-OPTICAL EFFECTS.

4868. Electric Birefringence of Camphor. M. Schwob. *Comptes Rendus*, 197. *pp*. 615–617, *Sept*. 18, 1933.—Contrary to some previous observations, the author along with Lucas, has shown that the magnetic double refraction of camphor shows anomalous dispersion and depends on the nature and concentration of the solvent. These points have been investigated in regard to the electric double refraction of liquid camphor and of solutions of racemic camphor in CCl_4 and in petrol at different temperatures. The results show that the dispersion in all cases is normal, that the variation with temperature obeys the Langevin law, that the nature modifies the value of the double refractivity, that in the case of petrol solutions the double refraction decreases with dilution. The results are in accord with the hypothesis of Lucas on the polymorphism of camphor in solution. J. E.

4869. Magneto-Optical Rotation of Nickel. K. H. v. Klitzing. *Zeits. f. Physik*, 85. 3–4. *pp*. 240–252, *Sept*. 4, 1933.—An examination of the Kerr effect and the Faraday effect in nickel, with their relations to temperature and to field intensity and the wave-length. In the Kerr effect the null-point at 1·5 μ did not change in position with varying temperature or field-strength; and the rotation was, within wide limits, proportional to the magnetisation. In the Faraday effect dispersion was quite similar to that in the Kerr effect, but the rotation was in the opposite direction. A. D.

4870. Absence of Inertia in the Diamagnetic Faraday Effect. W. Hanle. *Zeits. f. Physik*, 85. 5–6. *pp*. 304–309, *Sept*. 14, 1933.—Unlike the Kerr effect, which decreases at frequencies of the order of $10^8 \sim$ on account of the orientation inertia of the molecules in the electric field, the diamagnetic Faraday effect, a phenomenon associated with the Zeeman effect in the neighbourhood of absorption lines in gases, shows no inertia up to the highest obtainable frequencies of the alternating magnetic field ($10^8 \sim$). C. B. A.

4871. Time Lags in the Faraday Effect. J. S. Webb and D. R. Morey. *Phys. Rev*. 44. *pp*. 589–601, *Oct*. 1, 1933.—The nature of the initial or surge currents, and of the oscillatory currents, found in a magneto-optic apparatus similar to that used by F. Allison, has been investigated. Assuming the existence of a time lag in the Faraday effect, the nature of minima which could be produced by these currents is examined. The possible minima are found to be extremely broad, a matter of several metres rather than a few cm., and have such a small intensity change for a unit movement of the trolley as to be incapable of detection. Large and easily visible minima characteristic of the organic liquids used have been observed, whose explanation is found in terms of Verdet constant and a change in magnitude of current as a result of trolley movement. The effect of concentration on the appearance of minima arising from a Faraday effect is found not to agree with the experimental results of Allison. No sharp minima were found either with visual or photoelectric

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observation, and the conclusion is reached that the cause of the results of Allison is not a time lag in the Faraday effect, but is some as yet unknown cause, possibly a peculiar sort of Kerr phenomenon. AUTHORS.

See also Abstract 4873.

FLUORESCENCE AND PHOSPHORESCENCE. LUMINESCENCE AND AFTERGLOW.

4872. Fluorescence of Gaseous Formaldehyde. S. Gradstein. *Zeits. f. phys. Chem.* 22. *Abt.B.* 5–6. *pp.* 384–394, *Sept.*, 1933.—It is found that the fluorescent spectrum of H-CHO excited by monochromatic radiation is independent of the particular band used. This result is attributed to collisions, the excited molecules being transferred to the vibrationless state. The longest wave fluorescence band coincides with the principal absorption band, but the shortest wave fluorescence band corresponds to an absorption which is very weak. This is explained on the assumption that a forbidden electron jump is concerned, in accord with the Herzberg and Teller vibration selection rule. J. E.

4873. Quenching of Tellurium Vapour Fluorescence by Magnetic Fields. R. Smoluchowski. *Zeits. f. Physik*, 85. 3–4. *pp.* 191–200, *Sept.* 4, 1933.—A specially designed electrical oven for the study of fluorescence of vapours at high temperatures is described. The quenching effect of magnetic fields, so far known only for iodine is found to exist with Te vapour excited with Hg lines 4358 and 4046 Å. The quenching is different for different series and even for different members of a series. The results do not appear to be explicable by the assumption that the magnetic quenching is due to the lessening of the number of molecules in a given excited state. It is possible, in agreement with the Condon and Lenz intensity theory, to explain the results by an increased size of the molecules in the field, such as was observed by Berg. J. E.

4874. Reversal of Circular Polarisation in the Fluorescence of Thallium. W. Hanle. *Zeits. f. Physik*, 85. 5–6. *pp.* 300–303, *Sept.* 14, 1933.—The green fluorescence of thallium at 5350 Å, excited by irradiation with circularly polarised light from the thallium line at 3776 Å, is shown to be circularly polarised also, but in the opposite sense. A theoretical explanation of the phenomenon is given. C. B. A.

4875. Fluorescence of Diatomic Molecules of Antimony. J. Genard. *Phys. Rev.* 44. *pp.* 468–469, *Sept.* 15, 1933.—The phenomenon of fluorescence has been found for diatomic molecules of antimony excited by the lines 2967, 3022, 3126 and 3132 of a mercury arc. The formulæ for these resonance series give for the equilibrium interatomic separation 2·21 Å and for the moment of inertia 489×10^{-40} gm.cm^2. AUTHOR.

4876. Conservation of Moment of Momentum and Polarisation Rules in Spectroscopy. Application to Light Scattering and Fluorescence. A. Kastler. *J. de Physique et le Radium*, 4. *pp.* 406–420, *July*, 1933.—The way in which conservation of angular momentum leads to selection rules and polarisation rules in spectroscopy is briefly described. When there is no external field the selection rules apply, but it might be thought that nothing could be observed in respect of the polarisation rules, because the molecules are orientated at random. This is not the case, however, when atoms emit light by fluorescence or in a scattering process. The polarisation of the light emitted in these two processes is worked out in detail from the principle of conservation of angular momentum. The essential point in the analysis, is that the balance of angular momentum must be applied to the magnetic quantum number and not to the total quantum number as assumed by Raman and Bhagavantam. W. S. S.

4877. Polarisation of the Fluorescence Light from Pure Mercury Vapour. A. Kastler. *Comptes Rendus,* 197. *pp.* 442–444, *Aug.* 7, 1933.—When pure mercury vapour is irradiated with a parallel beam of light containing the wave-lengths 2537 and 4358 Å., the fluorescence lines at 4358 and 4046 Å appear rectangularly polarised, in directions at right angles to one another when viewed normally to the incident beam. The polarisation is incomplete owing to lack of parallelism of the incident light, the depolarising action of neighbouring atoms, the presence of the metastable state 2^3P_0, excited by the light of wave-length 4046 Å, the action of the earth's field, and the hyperfine structure of the lines. In pure mercury vapour, at low pressure, the orientation of the atoms concerned does not alter during the successive processes of absorption and re-emission, but if, *e.g.*, nitrogen is present the atoms undergo collisions between the processes and their orientation changes. H. F. G.

4878. Luminescence of Fluorites. Part II. H. Haberlandt. *Akad. Wiss. Wien, Ber.* 142. 2*a*. 1–2. *pp.* 29–33, 1933.—A new source of violet fluorite has been discovered, giving a red fluorescence. The strong radio photo luminescence which with certain fluorites with sulphide content is superimposed appears to be due to a sensitising effect of the sulphide in the Steinmetz sense. The various colours of the luminescence are intimately connected with the impurities present, notably rare earths and bituminous substances, but the red light is not considered to be due to rare earths as was formerly thought. [See also Abstract 2358 (1933).] J. E.

See also Abstracts 4841, 4842.

INTERFERENCE. DIFFRACTION AND SCATTERING.

4879. Determination of the Magnitude of Ultramicrons with the Interference Microscope. A. Klimmeck. *Zeits. f. Physik,* 85. 1–2. *pp.* 68–84, *Aug.* 29, 1933.—The principle of the Michelson interferometer is shown to be applicable to the microscope. A distinction is drawn between coherent and incoherent radiation. The method of measurement by the interference microscope is shown to be a considerable advance on previous methods, in that it possesses a theoretically unlimited resolving power, and hence smaller particles could be measured. F. J. B.

4880. Adaptation of the Interferometer for Hyperfine Structure. G. S. Monk. *Rev. Sci. Instruments,* 4. *pp.* 527–528, *Oct.,* 1933.

See also Abstracts 4876, 4910, 4912, 4955.

PHOTOCHEMISTRY.

4881. Quantitative Optical Determination of Photochemical Reaction Products. E. Miescher. *Göttingen Nachrichten. Math.-Phys. Klasse, No.* 3. *pp.* 329–334, 1933.—By photoelectric measurement of the absorption coefficients of halide crystals, in which absorption centres are produced photochemically, it is shown that the absorption method yields comparable results both when the centres are atomic and when they have been converted (by heating) to colloidal flocculated particles. The method can thus be used safely for the determination of the number of centres under both conditions. C. B. A.

4882. Effect of Light on Rubidium Iodide Vapour. M. S. Desai. *Zeits. f. Physik*, 85. 5–6. *pp.* 360–365, *Sept.* 14, 1933.—RbI vapour absorbs light in four regions at the wave-lengths 3700, 2900, 2548 and 2150 Å. The energies corresponding to these wave-lengths are 3·33, 4·25, 4·84 and 5·73 volts respectively. The first absorption region corresponds to the normal dissociation of RbI into Rb and I. The differences 0·92, 1·51 and 2·40 volts between the energy of the first and succeeding absorption regions are closely equal to the excitation potential of iodine, the excitation potential of rubidium and the sum of these excitation potentials respectively. The absorption regions therefore correspond to dissociation of RbI into Rb + I, Rb + I*, Rb* + I and Rb* + I* respectively. J. E. K.

4883. Apparatus for the Determination of the Colour Sensitivity of Photographic Layers. J. O. Brand. *Phys. Zeits.* 34. *pp.* 677–682, *Sept.* 1, 1933.—Describes in detail a method of determining sensitivities of photographic emulsions, making use of a compensating plate whose function, when used with a spectrograph, is to give equal energies over the whole spectrum, the light from a gas-filled filament lamp being utilised. Spectral sensitivity curves of four modern photographic emulsions, which have been determined using the arrangement described, are also given. R. C. F.

4884. Developers and Sensitivity. R. Davis and G. K. Neeland. *Bureau of Standards, J. of Research*, 11. *pp.* 379–407, *Sept.*, 1933.—In a study of several photographic developers, including the international sensitometric standard, *p*-aminophenol, it was found that the latter agent is not as satisfactory as certain metol-hydroquinone developers in two respects: (1) the "toe" region of the characteristic curve is increased, accompanied by an increased inertia; and (2) the recommended formula is not well chosen in that the solution is supersaturated. It is also found that the presence of soluble bromide in some developers gives, with some emulsions at least, an increased sensitivity with prolonged development. This effect should prove useful in those cases where high contrast is not detrimental. It was observed that, in general, the ratio of values of the two sensitivity indices varied considerably with development time. In fact, under certain conditions, values of one index ($1/i$) may be decreasing while values of the other ($1/E_m$) are increasing with development time. In order to consider these apparently contradictory changes a definition for relative sensitivity has been set up. From this definition it follows that comparisons of sensitivity may be made only when the emulsions have each received equivalent development. The type of emulsion with which each of these indices is particularly applicable is also indicated. The findings of Luther, that the gradient of the curve above the inertia point is approximately one half γ, are confirmed. The application of this constant to coordinate the inertia and gradient methods of specifying sensitivity is discussed. This information should help clear up the confusion surrounding the measurement of the sensitivity of photographic emulsions. AUTHORS.

4885. Intermittency Effect in Photographic Exposure. J. M. Blair and M. C. Hylan. *J.O.S.A.* 23. *pp.* 353–358, *Oct.*, 1933.—An explanation of the effects of intermittency in photographic exposures as reported by previous investigators is advanced on the basis of the latent-image-velocity eqnation suggested by Blair and Leighton, supplemented by the hypothesis of a photochemical lag. It is shown that in comparing continuous and intermittent exposure curves the difference in " efficiency " of the illumination in the two types of exposures is more fundamental than the differences in final density. It is predicted that using low intensity light with slow emulsions, there being a relatively long period of darkness intervening between exposures, then much greater intermittency effects than any so far reported should be obtained, this being the case both for magnitude and variation with wave-length. Experimental data are presented which fulfil these predictions. A. H.

4886. Time Lag in the Formation of the Latent (Photographic) Image. L. I. Zimmerman. *J.O.S.A.* 23. *pp.* 342–352, *Oct.*, 1933.—Two distinctly separate series of constant energy exposures were made on Hammer extra fast plates at several different light intensities. Another short series was made on a Hammer slow emulsion. The intermittent but constant energy exposures were provided by two different rotating mirrors whose ranges of speeds were 1900 r.p.s. and 750 r.p.s., respectively. The emulsion grains were illuminated for periods varying from 10^{-5} sec. to $5{\cdot}5 \times 10^{-8}$ sec. duration. The rotating mirrors made it possible to obtain data on the intermittency effect for much shorter time exposures than was possible for Davis or for Weinland using selected wave-lengths. The data secured have a bearing on the Brush effect. The diffuse densities of the images on the emulsions were measured by an adaptation of the Richtmyer differential photoelectric photometer. With a decrease in the time of duration of the flash, there was found a gradual diminution of the image density until a critical flash interval or period was reached, after which the density-flash period curve fell rapidly with small decreases in the flash period. The breaking point in the curve varied within experimental limits for the two mirrors but for high light intensities approximated 1×10^{-7} sec. while for the lower intensities the break occurred in the region of longer intervals. The conclusions reached from the interpretation of the data are: that the quantum theory applied to light in this particular field fails; that the real intermittency failures of any magnitude occur in the region of shorter flash or exposure intervals; and that the formation of the latent image can probably be explained as a resonance process.

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4887. Influence of Opening of Pencils Used in Determining Photographic Density. G. A. Boutry. *Comptes Rendus*, 197. *pp.* 642–643, *Sept.* 25, 1933.—The density of the resultant negative as determined by the author's method [see Abstract 2972 (1933)] is plotted against the opening (*a*) when a pencil of light 0·012 steradian, after traversing a ground glass plate and passing through an opening of 0·012–3·74 steradian, falls on the photographic plate; and (*b*) when the incident pencil passes first through an opening varying from 0·012 to 0·8 steradian, and then after traversing the ground glass plate and being kept constant at 0·012 steradian, falls on the photographic plate. For the same opening the density for (*b*) is always $>$ that for (*a*); the difference (maximum about 13 %) being greatest for openings $\not>$ 0·2 steradian. C. A. S.

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4888. Electrostatic Properties of Photographic Films. D. C. Rose. *Canad. J. of Research*, 9. *pp.* 197–216, *Sept.*, 1933.—This paper deals with experiments performed to determine the electrostatic properties of celluloid camera films. The information derived was used in attempts to eliminate marks due to static electricity on film used in aerial photography. Camera films were rubbed with wool or brass and the resulting electrostatic effects studied. The required atmospheric conditions were reproduced by carrying out the experiments in a tank in which pressure, temperature and humidity could be controlled independently. It was found that the charging effect was more pronounced in a moist than a dry atmosphere. Methods of eliminating the trouble caused by static electricity in aerial photography are discussed. AUTHOR.

PHOTOMETRY.

4889. Heterochromatic Photometry with Tungsten Filament Lamps. G. Ribaud. *Rev. d'Optique*, 12. *pp.* 193–200, *May*, 1933.—The author proposes a method of comparing the luminous intensities of two tungsten filament lamps at different colour temperatures by making a spectrophotometric comparison at or near the Crova wave-length for this pair of colour temperatures. For instance, the Crova wave-length is 573·0 $m\mu$ for the temperatures 2080 and 2360° K., and the ratio of the intensities of the light at this wave-length is the same as the ratio of the total candle-powers, assuming the international luminosity curve. The influence of the value of C_2 in the Wien-Planck equation, the effect of the colour emissivity of tungsten and its departure from exact similarity with a grey body are discussed, and found to lead to errors of negligible magnitude. The author shows how this method can be applied to determine the transmission factors of the blue filters used in heterochromatic photometry. J. W. T. W.

4890. Photometry of Gaseous Discharge Tubes. W. Dziobek and O. Reeb. *Zeits. f. techn. Physik*, 14. 9. *pp.* 350–353, 1933.—The measurement of the candle-power of a gaseous discharge tube, such as a sodium vapour tube, introduces in an acute form the uncertainties inseparable from heterochromatic photometry. The author proposes the use of a yellow gelatin filter which, in conjunction with a tungsten filament vacuum lamp, gives a sensation colour match with the sodium tube. Using this combination as a standard, four observers obtained a number of sets of measurements with a precision of about 2 %. The paper contains full details of the precautions taken in trying out the method. It is concluded that it provides a satisfactory solution of the problem. The spectral transmission curve of the filter is given, but not its composition. J. W. T. W.

4891. Automatic Tracer for Light Distribution Curves. R. Sewig and W. Vaillant. *Zeits. f. Instrumentenk*, 53. *pp.* 388–396, *Sept.*, 1933.—Describes apparatus for obtaining a record of the polar curve of candle-power distribution from a light source. The source is rotated slowly in any desired plane through its vertical axis and the light emitted in a horizontal direction falls on a cæsium photoelectric cell. The current through the cell is amplified and operates a pointer which moves a pen over a chart. The movement of the chart past the pen is synchronised with the rotation of the light source so that the curve traced out by the pen is the curve of light distribution. The accuracy is estimated at 0·1 lux on the cell so that if a precision of 1 % at the maximum point is aimed at, the illumination at this point must be adjusted to 10 lux. The apparatus as described can only be used for a source which can be rotated; the example selected is a motor-car headlight. J. W. T. W.

4892. Applications of Rectifier Photoelectric Cells in Photometry. B. Lange. *Zeits. f. Instrumentenk*, 53. *pp.* 344–349, *Aug., and pp.* 379–387, *Sept.*, 1933.—The author first gives a summary of the characteristics of various photovoltaic (rectifier, or *Sperrschicht*) cells as far as these affect their use for photometric purposes. The spectral sensitivity curve of the selenium cell is nearest that of the eye and, by the use of a coloured glass filter, the luminosity curve may be very closely imitated. The linearity of response varies and by properly choosing the external resistance of the circuit a satisfactory linearity may be obtained over a very wide range of illumination. For Cu_2O cells the temperature coefficient of the response is from 0·1 to 1 % per °C. For a selenium cell it is much less (0·03 % per °C.). The departure from the cosine law of illumination is serious for many types of cell. Diagrams are given to show this effect for four types. The use of a selenium cell as an illumination photometer is described. In combination with an opal glass sphere it can be used to measure the " total flux density " at any point in a room. Other applications of the cell are: (1) to measure quantity of light, for such purposes as a study of fading; (2) in spectrophotometry; (3) in colorimetry; (4) in the measurement of the reflection characteristics of materials; and (5) in microphotometry. The paper concludes with a Bibliography of the subject. J. W. T. W.

4893. Photometric Measurements Using Gas-Filled Photoelectric Cells. T. D. Gheorghiu. *Ann. de Physique*, 20. *pp.* 133–242, *Sept.*, 1933.—A spectrophotometer is described employing two gas-filled photoelectric cells and adapted for use with light sources not completely steady. It depends upon the linear relation between photoelectric current and intensity of illumination, and the methods used to test whether the cells fulfilled this condition are described. The method of making the high resistances used in the circuit is described. Careful attention is paid to the elimination of possible sources of error, the question of diffused light in the optical system in particular, while during a series of experiments the apparatus is frequently checked by taking readings on a previously standardised solution of copper sulphate. The applicability of Beer's law to solutions of copper sulphate, cupric chloride, racemate and tartrate of copper is tested. The law is found to hold only for the sulphate, and the failure in the case of the others is explained by the formation of complex ions. It is found that right-handed and left-handed copper tartrate have the same absorption curves, but that when they are mixed a different curve is obtained. An attempt to use photoelectric cells in polarimetry is described. D. H. F.

4894. Match-Points in Divided Beam Spectrophotometry. R. J. MacWalter and S. Barratt. *Journ. Sci. Instruments*, 10. *pp.* 312–314, *Oct.*, 1933.—Interference fringes are used instead of lines of a discontinuous source for determining match-points in divided beam spectrophotometry. In this way errors arising from the use of the metal spark may be eliminated without the inconvenience of continuous sources. AUTHORS.

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4895. Primary Standard of Light. G. Ribaud. *Rev. d'Optique,* 12. *pp.* 289–301, *Aug.,* 1933.—Describes a series of researches conducted on the standard of candle-power proposed by the Bureau of Standards. The platinum in the crucible was melted by means of a h.f. induction furnace of the spark type dissipating about 3 kW. The range of values of brightness observed during any one melt or freeze of the platinum was generally less than 1 %. The final value is given as 58·78 candles per cm^2. The author draws the conclusion that this form of the black-body standard of light is readily reproducible. Nevertheless, it is possible that some improvement of detail might be introduced. In particular it would be advantageous to use a horizontal tube instead of a vertical one, and so avoid the uncertainty introduced by allowing for the absorption of light in the total reflection prism. J. W. T. W.

See also Abstract 5005.

POLARISATION.

4896. Rotatory Dispersion and Circular Dichroism of Aldehydic Sugars. H. Hudson, M. L. Wolfrom and T. M. Lowry. *Chem. Soc., J. pp.* 1179–1192, *Sept.,* 1933.—The acetates of the open-chain aldehydic μ-forms of glucose, galactose, and arabinose have a characteristic carbonyl absorption band at 2900 Å which is optically active and gives rise to a lævo-rotation in the visible spectrum. The dissymmetry factor $(\epsilon_r - \epsilon_l)/\epsilon$ is approximately proportional to the frequency, but falls off slightly on the side of shorter wave-lengths, although this anomaly is less marked than in the cases of camphor and camphor-β-sulphonic acid. The rotatory dispersions include a lævo-rotation due to the induced dissymmetry of the aldehyde group and a dextro-rotation with a characteristic frequency in the Schumann region which is attributed to the fixed asymmetry of the $> CH \cdot O \cdot CO \cdot CH$ groups. For tetra-acetyl μ-arabinose the Schumann terms cancel out and all the rotation is due to the aldehydic group. The partial rotations due to this can again be best represented by the equation of Lowry and Hudson. The principle of optical superposition and the validity of C. S. Hudson's rules of iso-rotation are discussed in the light of the results now obtained. [See Abstract 4068 (1933).] C. B. A.

4897. Nature and Extent of the Scattering Moment in Optically Active Molecules. W. Kuhn and K. Bein. *Zeits. f. phys. Chem.* 22. *Abt. B.* 5–6. *pp.* 406–422, *Sept.,* 1933.—Earlier considerations of the size of the anisotropy factor in optically active absorption bands are extended to the case in which the scattering moment belonging to a vibration does not possess an essentially dipole character but is wholly or in part quadripolar. The difficulties previously met with, consisting chiefly of the too high values (up to 80 Å) obtained for the extent of the scattering moment in the molecule, now disappear, the equation $d \geq g\lambda/2\pi$ being replaced by $d \geq g\lambda\sqrt{3f}/4\pi$. The theory which previously applied only to a single molecule is extended to a random orientation of molecules, and conclusions are drawn as to the relationships existing between the quantities d, g, and f in terms of the Kuhn model for an optically active molecule. [See Abstract 3975 (1930).] C. B. A.

See also Abstracts 4728, 4874, 4876, 4877, 4893.

RADIATION, EMISSION.

4898. Initial Temperature of Grey Radiation in Metals, Oxides and Sulphides. G. Tammann and W. Boehme. *Ann. d. Physik,* 17. 8. *pp.* 863–868, *Aug.,* 1933.—When a solid body is heated, its light emission begins with a glistening grey radiation, which on further rise of temperature finally passes into a dull red. The temperatures at which the grey radiation commences had been determined [see Abstract 577 (1933)] for previously melted or strongly heated salts. These temperatures were between 280° and 390° C. If the crystallised salt derived from a previous melt or the previously highly heated salt is ground up, the temperature of grey radiation is lowered as a rule by 50° to 150° compared with the natural salt. The present paper gives results of further experiments along these lines for NaCl, KCl and WO_3. The intensity of grey radiation for metals is much smaller than for salts. The hardness or softness of the metal affects the temperature of grey radiation. Results are given for a considerable number of oxides and sulphides. The lowering of the temperature of grey radiation varies from 2° to 109° C. T. B.

4899. Cosmic Ray Light on Nuclear Physics. R. A. Millikan. *Science,* 78. *pp.* 153–158, *Aug.* 25, 1933.—A summary is given of recent work. Both in the case of ThC'' rays and in that of cosmic rays a common procedure when a photon is absorbed by the nucleus of an atom is for a positive and negative pair to appear together, both generally having the same mass, that associated with the free negative electron. From measurements on particles of energies between 6×10^6 and 3×10^9 volt electrons it appears that the positive and negative energies are alike both as to their numbers and the distribution of their values. The incident cosmic rays are absorbed primarily by the nucleus rather than by extra-nuclear electrons as heretofore assumed. Practically the whole of the energy of the incident photon should be able to appear in a single ejected proton or electron, or in a number of such. The observed energy distribution of the cosmic ray particles is not far from the energy distribution of the primary rays producing the secondary ionising particles. The fact of the absorption of cosmic rays being practically wholly nuclear means that all the computations so far made with the object of obtaining cosmic ray energies from absorption coefficients with the aid of the Klein-Nishina formula are invalid. The rays at an altitude of 22,000 feet are on the average very much less penetrating than the rays at sea-level. Calculations on the energy problems point to the conclusion that the major part of the ionisation of the atmosphere by cosmic rays is due to incoming rays of an energy corresponding in order of magnitude to the synthesis of one of the lighter elements out of hydrogen. It is estimated that the total cosmic ray energy falling into the earth is approximately one-half of the total energy coming in from the stars. J. J. S.

4900. Variation of Cosmic Radiation. Part II. W. Messerschmidt. *Zeits. f. Physik,* 85. 5–6. *pp.* 332–335, *Sept.* 14, 1933.—In an earlier paper [see Abstract 212 (1933)] the author showed that variations in cosmic radiation could be explained by meteorological influences and concluded that the primary cosmic radiation was constant within the limits of accuracy of measurement. The present paper deals, in the light of these earlier observations, with the so-called variations of the second kind. These latter variations are now shown to be correlated with the fluctuations of barometric pressure and the earth's magnetic field. A. B. W.

4901. Absorption of Penetrating Radiation in Water and Analysis of the Absorption Function. W. Kramer. *Zeits. f. Physik,* 85. 7–8. *pp.* 411–434, *Sept.* 23, 1933.—In the first part of the paper a description is given of the absorption measurements of the cosmic radiation in the water of an alpine lake near Immenstadt, carried out in 1929. The absorption function is set out. In the second part the analysis of the absorption function is carried out by a new method. It is shown that a full analysis of the absorption function in a simple way can only be carried out with the help of a function which besides the primary radiation incident on all sides takes into account the scattered radiation. The analysis yields four components whose sum exhibits the measured function in the whole range from 1·8 to 230 m. of depth of water within the measured limits of error. A criterion for the correctness of this exhibition is found in the course of the apparent absorption coefficients. From the ionisation current the number of the impulses is calculated and found in good agreement with the numbers which were established by Regener with the counting tube at Lake Constance in 1931. The energy values and wave-lengths of the components are set out, on the basis of the Klein-Nishina theory of the wave scattering at free electrons. J. J. S.

4902. Penetration Capacity and Absorption Coefficient of Ultra-Radiation. E. Lenz. *Zeits. f. Physik,* 85. 7–8. *pp.* 435–438, *Sept.* 23, 1933.—Taking into account the scattered radiation there is found for the connection between absorption coefficient μ and penetration capacity or mean range R_m of cosmic radiation the relation $R_m = 3 \cdot 1/\mu$ and not as usually assumed $R_m = 1/\mu$. As a result of this some contradictions between absorption coefficient and penetrating capacity of cosmic radiation are explained. J. J. S.

4903. Dependence on Pressure of the Residual Ionisation in Cosmic Ray Measurements. P. Pfundt. *Zeits. f. Physik,* 85. 7–8. *pp.* 439–441, *Sept.* 23, 1933.—The dependence on pressure of the residual ionisation was investigated in a high pressure ionisation chamber filled with CO_2 gas. The curve thus obtained is discussed. J. J. S.

4904. Dependence on Pressure of the Residual Ionisation. E. Körner. *Zeits. f. Physik,* 85. 7–8. *pp.* 442–447, *Sept.* 23, 1933.—The course of the pressure ionisation curves in cylindrical chambers whose inner wall is covered with various radiaoctive substances gives a simple explanation of the characteristic course of the pressure dependence of the residual ionisation as Pfundt has found it. With a coating of uranium oxide on the wall two maxima appear in the pressure ionisation curve. By screening off the α-rays and the soft β-rays by means of lac there remains only the weaker β-maximum, whilst conversely with a Po surface coating emitting only α-rays, only the stronger α-maximum appears. Form and position of the maxima find their explanation through calculations which take into consideration the pressure dependence of the columnar ionisation investigated by Jaffé and that of the radiation effectively used in the chamber. J. J. S.

4905. Pressure Dependence of the Residual Ionisation. J. A. Priebsch. *Zeits. f. Physik,* 85. 7–8. *pp.* 448–450, *Sept.* 23, 1933.—The pressure dependence of natural residual ionisation which was investigated in air and argon in a pressure-resisting Kolhörster radiation apparatus formed out of delta metal, shows substantially the characteristic peculiarities mentioned by Körner [see preceding Abstract]. The variation of the pressure dependence with the gases employed can be explained on the ground of the various densities and saturation relations. J. J. S.

4906. Cosmic Ray Hodoscope. T. H. Johnson and E. C. Stevenson. *Frank. Inst., J.* 216. *pp.* 329–337, *Sept.*, 1933.—The cosmic ray hodoscope consists of a large number of small Geiger-Müller counters stacked in a two dimensional array or bank. Each counter is connected through one stage of amplification to a neon glow lamp which occupies a position on a panel corresponding to the position of the counter in the bank. The discharge of a counter, initiated by an ionising ray, thus produces a flash in the lamp to which it is connected, and with a similar geometrical arrangement between counter bank and lamp panel, a sequence of counters discharged simultaneously by one of the penetrating corpuscular rays produces an illuminated track. These tracks may be photographed or observed visually. The hodoscope therefore accomplishes to a limited extent the same purpose as the Wilson cloud chamber, but it has the advantage of being continuously sensitive. F. C. C.

See also Abstracts 4834, 4848, 4849, 4850, 4895.

RADIATION, GENERAL THEORY.

4907. Theory of Radiation. J. Solomon. *J. de Physique et le Radium*, 4. *pp.* 368–387, *July*, 1933.—The author discusses the relationship between the classical electromagnetic and the quantum theory of radiational processes. Starting from the classical expression for the energy radiated by an accelerated electron, it is shown how the result can be taken over into the quantum theory by making use of Heisenberg's principle of indeterminacy. Application is made to the calculation of the radiation emitted by an electron in collision with a nucleus and the Kramers formula is obtained. Another application, to the case of very high velocity particles in collision, leads to the conclusion that the radiation emitted in collisions between cosmic ray electrons and electrons is, in general, very feeble. With regard to the measurement of magnetic and electric fields by means of the change of momentum of a particle in a collision, it is shown that contrary to the suggestion of Landau and Peierls such a method gives an error which exceeds that required by the quantum theory of Heisenberg and Pauli. W. S. S.

See also Abstracts 4782, 4855.

REFLECTION. REFRACTION AND DISPERSION.

4908. Optical Properties, Densities, and Solubilities of the Normal Formates of some Metals of Group II of the Periodic System. F. W. Ashton, D. F. Houston and C. P. Saylor. *Bureau of Standards, J. of Research*, 11. *pp.* 233–253, *Aug.*, 1933.—This paper presents data on the optical properties, densities, and solubilities in water from 0 to 100° C. of the normal crystalline formates of calcium, strontium, barium, magnesium, zinc and cadmium. The optical properties determined are the refractive indices, optic axial angle, elongation, interference figure, and dispersion. The crystal system and habit are also given. The literature on previous work is discussed in connection with the present results. The system water-magnesium formate dihydrate was investigated and found to have a eutectic temperature of $-5\cdot05°$ C. $\pm 0\cdot03$ at a composition corresponding to $14\cdot0$ gm. $\pm 0\cdot1$ of anhydrous salt per 100 gm.

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of water. The transition temperature of strontium formate dihydrate to anhydrous formate was found to be 72·0° to 72·5° C. and that of cadmium formate dihydrate to anhydrous formate to be 66·0° to 66·5° C. Harris's adaptation of Dühring's relation is applied to these salts, with cæsium chlorate as a reference salt. AUTHORS.

4909. Optical Properties of the Double Salt $(NH_4)_2SO_4, CaSO_4, 2H_2O$. A. R. Merz, J. O. Hardesty and S. B. Hendricks. *Am. Chem. Soc., J.* 55. *pp.* 3571–3573, *Sept.*, 1933.—The double salt was found in the solid phase after adding gypsum to saturated ammonium sulphate solution, evaporating, and allowing to stand for several days. It is decomposed by water, alcohol, or ether. The crystals are flat needles and optically negative; refractive indices N_D: α 1·522; β 1·527; γ 1·529; density 2·07. The molecular refractivity and volume were found to follow the additive rule of the constituents. N. M. B.

4910. Rotating Chamber for the Determination of Refractive Indices of Solutions by Interferometry. A. Kruis and W. Geffcken. *Zeits. f. phys. Chem.* 166. *Abt. A.* 1–2. *pp.* 16–23, *Sept.*, 1933.—Full details are given of the construction and method of use of the apparatus. The interferometer chamber consists of two parts, one of which contains the solution to be tested and the other the standard solution or solvent. It is rotated from the normal position and the displacement of the interference bands observed, this depending upon the angle of rotation and the order of the interference in the normal position. It is used with a Haber-Löwe interferometer. This method is simpler and more convenient than the method of "achromatic bands." The theory underlying the method is explained and results are tabulated which have been obtained with solutions of NaCl. Good control and a high degree of accuracy are attainable. R. S. R.

4911. Dispersion Measurements on Sodium Chloride in the Long Wave Infra-Red. C. H. Cartwright and M. Czerny. *Zeits. f. Physik*, 85. 5–6. *pp.* 269–277, *Sept.* 14, 1933.—Measurements are made of the index of refraction and extinction coefficient of rock-salt in the region 70–125μ. Curves of transmissibility wave-length and refractive indices and extinction coefficients for various thicknesses are given. No anomalies corresponding to the "secondary maxima" on the short-wave side of the infra-red vibration were found. W. R. A.

4912. Dispersion of Gases and Vapours. Part V. Interferometer for Schumann Region. G. Wolfsohn. *Zeits. f. Physik*, 85. 5–6. *pp.* 366–372, *Sept.* 14, 1933.—A Jamin-Machs interferometer with a fluorspar optical system is described in which the optical path lies wholly in a vacuum. This instrument, in conjunction with a fluorspar vacuum spectrograph, is suitable for the measurement of dispersion in the Schumann region. Preliminary measurements of the anomalous dispersion of the Hg 1850 Å line give a value of 1·3 ± 0·15 for the *f*-value of this line. [For Part IV see Abstract 3531 (1933).] J. E. K.

4913. Source of Error in Measurement of Transmission of Optical Instruments. B. Cuny. *Rev. d'Optique*, 12. *pp.* 201–203, *May*, 1933.—Draws attention to an error in measuring the transmission of optical instruments by determining the brightness of a diffusing surface viewed (*a*) directly, (*b*) through the instrument under examination. This error may amount to as much as 20 % in some cases, if the diffusing surface is not placed a sufficient distance from the first lens of the instrument.

W. S. S.

See also Abstracts 4728, 4879, 4946, 4947.

SPECTROSCOPY.

4914. Wave-Length Comparator. G. Glockler and F. W. Fullerton. *Rev. Sci. Instruments*, 4. *pp.* 530–531, *Oct.*, 1933.—A wave-length comparator has been constructed, in which the microscope moves along the direction of the measuring screw and the platform carrying the photographic plate has an independent motion at right angles to the direction of the screw. A split nut which is part of the microscope carriage permits release from the screw and a quick motion of the microscope from one end of the photographic plate to the other. AUTHORS.

4915. Preliminary List of Terms for the Arc Spectrum of Tantalum. C. C. Kiess and Harriet K. Kiess. *Bureau of Standards, J. of Reseacrh*, 11. *pp.* 277–278, *Aug.*, 1933.—A preliminary list of Ta I terms, accounting for most of the strong arc lines, is presented. The low ^{4}F and ^{4}P terms and the metastable ^{6}D and ^{4}D terms are identified with those to be expected theoretically from the electron configurations $5d^3 \cdot 6s^2$ and $5d^4 \cdot 6s$. AUTHORS.

4916. Second Spectrum of Krypton. T. L. de Bruin, C. J. Humphreys and W. F. Meggers. *Bureau of Standards, J. of Research*, 11. *pp.* 409–440, *Sept.*, 1933.—The second spectrum of krypton (Kr II) characteristic of once ionised krypton atoms (Kr^+) has been selected from various krypton spectra excited in Geissler tubes by noting intensity changes accompanying variations of capacity and inductance in the electrical circuit. The description and analysis of the Kr II spectrum includes estimates of relative intensities and wave-length measurements for 1050 lines extending from 2080·53 Å in the ultra-violet to 10,659·5 Å in the infra-red. Most of these lines (71 %) have been classified as combinations of 128 energy levels, 112 of which have been more or less definitely identified with quantum numbers and electron configurations. Zeeman effects are quoted for 102 lines. In addition, 51 lines in the extreme ultra-violet (575·92 to 964·93 Å) are classified as transitions from excited states to the normal ones. The s^2p^5 electron configuration of the normal Kr^+ ion is represented by a doublet P term with level separation 5371 cm^{-1}., and the excited states are described by doublet and quartet terms arising from the addition of *ns*, *np*, *nd*, *nf* electrons to the s^2p^4 group constituting the outer structure of the doubly charged ion (Kr^{++}). An absolute value of 198,182 cm^{-1}. is derived for the ground level $s^2p^5.{}^2P^{\circ}_{0\frac{1}{2}}$, which fixes the ionisation potential of Kr^+ atoms at approximately 24·4 volts. AUTHORS.

4917. Spectrum of Doubly Ionised Neon in the Extreme Ultra-Violet. V. v. Keussler. *Zeits. f. Physik*, 85. 1–2. *pp.* 1–3, *Aug.* 29, 1933.—The spectrum of doubly ionised Ne was examined in the extreme ultra-violet, using a vacuum grating spectrograph. The wave-lengths found are tabulated, and consist of the combinations of the fundamental term $2p\,{}^3P_{0,1,2}$, with the higher terms $3s(^4S)\,{}^3S_1$, $3d(^4S)\,{}^3D_{1,2,3}$, $3s(^2D)\,{}^3D_{1,2,3}$, and $3s(^2P)\,{}^3P_{0,1,2}$, with corresponding multiplets. W. R. A.

4918. Absorption in the Far Ultra-Violet of Aqueous Solutions of Hydrochloric Acid. R. Tréhin. *J. de Physique et le Radium,* 4. *pp.* 440–456, *Aug.,* 1933.—The influence of temperature and concentration on the absorption of aqueous solutions of hydrochloric acid is studied between 2816 and 1990 Å. The results indicate that Beer's law is not obeyed and that the absorbing particles are not all identical in kind. Association between Cl^- ions, undissociated acid molecules, and water may occur, and the number of aggregates per unit volume and their structure would vary with concentration and temperature. Further investigations are in progress. [See also Abstract 1039 (1933).] C. B. A.

4919. First Spark Spectrum of Gold (Au II). B. V. R. Rao. *Roy. Soc., Proc.* 142. *pp.* 118–128, *Oct.* 2, 1933.—The paper embodies an extension of the analysis of the Au II spectrum. The configurations considered are $5d^8\,6s^2$, $5d^9\,6d$ and $5d^8\,6s7s$. Of the terms arising from the first two configurations, some definitely and some tentatively have been fixed by McLennan and McLay, the first to classify the lines of this spectrum. In the present paper thirty terms have been newly located and more than one hundred lines classified. To make the list self-contained other relevant lines have been included. AUTHOR.

4920. Perturbations in the Ba I Spectrum. G. O. Langstroth. *Roy. Soc., Proc.* 142. *pp.* 286–308, *Oct.* 2, 1933.—A study is made of the intensity perturbations in the Ba I spectrum. An arc running in nitrogen is used as a source, special precautions being taken to overcome self-absorption, whilst the spectrograms are obtained on a Hilger E1 instrument. Intensity measurements are made and the ratio of the singlet to the total triplet intensity is obtained for the first three members of the fundamental series. An explanation is offered for the fact that this ratio is too large. Intensity measurements are also made for various transitions to the 2^3P and 3^3D levels which form the two perturbation groups. The perturbations are discussed in detail and it is shown that the large departures from the normal intensities which occur in the multiplets considered are due to interactions of " overlapping " electron configurations. The results are also employed to assign various *j* values and to classify certain " irregular " lines. A. H.

4921. Intensity Relations in the Cadmium Spectrum. J. L. Verhaeghe. *K. Akad. Amsterdam, Proc.* 36. 1. *pp.* 71–73, 1933. *In German.*—Measurements carried out by photographic methods are briefly described. The method of correcting for self-absorption is described, and results given. Comparisons with theoretical predictions are made. D. H. F.

4922. Intensities of Spectra Emitted by H.F. Discharges in Helium. J. E. Keyston. *Phil. Mag.* 16. *pp.* 625–639, *Sept.,* 1933.—Photographic measurements are made of the intensities of portions of the line, band and continuous spectra emitted by the uniform column of a high-frequency discharge in helium. For a constant current the line spectrum decreases rapidly in intensity as the pressure of the helium is increased from about 1 to 40 mm., whilst the intensities of the band and continuous spectra increase over this same range of pressure. At constant pressure the intensities of all three types of spectra vary directly as the current strength for small currents (30 mA.). Adopting a theory of the uniform column given by Townsend, the excitation potential of the line spectrum can be calculated from the observed intensities by assuming a formula for the distribution of the energies of the electrons about the mean energy. A distribution formula is given which leads to a value of the excitation potential of about 23 volts, in good agreement with the theoretical value. Similar calculations show that the excitation potentials of the band and continuous spectra are considerably lower than that of the line spectrum. The experimental results cannot be rationally interpreted on the basis of the most generally accepted theoretical model of the helium molecule. J. E. K.

4923. Fine Structure and Natural Width of Self-Reversed Spectral Lines. E. Lau, O. Reichenheim, and J. Johannesson. *Ann. d. Physik*, 18. 1. *pp.* 97–106, *Sept.*, 1933.—The observed asymmetry of Ne lines on self-reversal is caused by a difference in temperature of the emitting and absorbing gas and by the doublet character of neon. By stronger self-reversal one can recognise the point of intersection of the dispersion distribution of intensity with the Doppler distribution; the natural half-width of the lines can be calculated by this means. Ne has two groups of lines whose natural half-widths are in the ratio 1 : 2; the lines of the former group originate from non-metastable ground states and those of the latter group from metastable ground states. The mercury line 5461 Å has three non-reversing components and the line 4358 Å has one non-reversing component. Hg 4358 Å has a larger natural half-width than 5461 Å. The principal line of Hg 5769 Å is not of single structure. J. E. K.

4924. Hyperfine Structure and Nuclear Moments of Krypton. H. Kopfermann and N. Wieth-Knudsen. *Zeits. f. Physik*, 85. 5–6. *pp.* 353–359, *Sept.* 14, 1933.—From analysis of a series of lines of the KrI spectrum the hyperfine structure separations of seven terms are deduced and arranged in a term scheme which is consistent with a value $I \geqq {}^7/_2$ for the nuclear moment of Kr^{83}. From the inverted arrangement of six of these terms it is concluded that Kr^{83} has a negative magnetic moment. The components of the even istopes (78, 80, 82, 84, 86) fall together at the centre of gravity of Kr^{83}. J. E. K.

4925. Hyperfine Structure in Intermediate Coupling. G. Breit and L. A. Wills. *Phys. Rev.* 44. *pp.* 470–490, *Sept.* 15, 1933.—The theory is extended to intermediate coupling and to cosine laws of force between nucleus and electron varying with different powers of their distance apart. In addition to Goudsmit's constants a', a'', there appears a third coupling constant a''' for each electron, which gives energy matrix elements for the same l and different j. The theory is in approximate agreement with observation. The gross structure is used to determine the parameters of the theory of intermediate coupling and hence $\overline{(1/r^3)}$. This together with a'' gives nuclear magnetic moments having roughly the same value for different configurations and stages of ionisation. The variation of $1/r^3$ as determined from gross structure shows changes in screening agreeing with those supposed to exist for $(6s)^2$ of Pb I, Tl I in order to explain the isotope shift as due to differences in nuclear radii. The discrepancies between gross structure and theory are shown to be connected with similar discrepancies in hyperfine structure and the discrepancies of the ratios a''/a' are reasonably explained by perturbations due to other configurations. AUTHORS.

4926. Nuclear Spin of Li^7 from Hyperfine Structure Data. N. M. Gray. *Phys. Rev.* 44. *pp.* 570–574, *Oct.* 1, 1933.—Theoretical patterns for the 5485($1s2s\ ^3S - 1s2p\ ^3P$) line of Li II have been calculated assuming nuclear spin values of 3/2, 2 and 5/2 in units of $h/2\pi$. Comparison of experimental measurements of Schüler and of Granath confirm the previously accepted value of $i = 3/2$ for the spin of Li^7. It is also shown that $i = 5/2$ can be excluded and that $i = 2$ is quite improbable. The calculation follows the method used by Güttinger and Pauli and includes the 6 % correction for the effect of the 2*s* electron worked out by Breit and Doermann. AUTHOR.

4927. Theoretical Optics of the Hydrogen Molecule. B. Mrowka. *Zeits. f. Physik*, 84. 7–8. *pp.* 448–465, *Aug.* 7, 1933.—Starting with a calculation for the polarisability of the hydrogen molecule [see Abstract 4479 (1932)] for different nuclear separations the influence of nuclear *verschmierung* on the mean polarisability and degree of depolarisation has been calculated. The intensities of all the Raman lines and the influence of Raman displacements on the degree of depolarisation have been investigated and compared with observed data. W. R. A.

4928. Dissociation of Diatomic Molecules with *p*-*p*-Bindings. H. Lessheim and R. Samuel. *Zeits. f. Physik*, 84. 9–10. *pp.* 637–656, *Aug.* 12, 1933.—By comparing the electron configurations of molecular terms and the energies for bound and free atoms it is shown that the different electrons in the atoms influence the binding force. Results are given for various odd and even numbered molecules and radicals, including BeO, NO, PO, BeF, MgF, CaF, SrF, AlO, PbO and SnCl. The particular significance of anomalous terms of the atoms for the above-mentioned molecules is discussed and it is shown that the dissociation energy increases with the state of excitation. W. R. A.

4929. Isotope Shift in Neon. J. H. Bartlett, Jr., and J. J. Gibbons, Jr. *Phys. Rev.* 44. *pp.* 538–543, *Oct.* 1, 1933.—The theory of isotopic displacement due to the motion of the nucleus has been extended to atoms with any number of electrons (assuming Russell-Saunders coupling) and applied to the transitions $2p^5\,3s - 2p^5\,3p$ in neon. Approximate Hartree wave functions have been obtained and orthogonalised. The theory gives a shift in singlet states of 0·0195 cm^{-1}. more than that in triplet states, as against approximately 0·017 cm^{-1}. measured by Nagaoka and Mishima. However, the calculated shift for the singlet transitions is 0·0038 cm^{-1}. as against the experimental value of 0·0332 cm^{-1}. This discrepancy may disappear if better wave functions are found. AUTHORS.

4930. Multiplet Separations and Perturbed Terms. N. G. Whitelaw. *Phys. Rev.* 44. *pp.* 544–550, *Oct.* 1, 1933.—It is well known that the multiplets in spectral series show an anomalous widening in regions where they are strongly perturbed by a vagrant term of large multiplet structure, which tends to impress its characteristics upon the series. In this work formulæ are derived for the multiplet widths of perturbed terms, which permit of the calculation of the separation of the multiplet levels providing the total shift of the " centres of gravity " of the multiplets from their unperturbed values is known. If a Ritz correction, $n^* = n - 0\cdot03629 + 0\cdot0399/n^2$, is assumed to give the positions of the terms exclusive of interaction with the perturbing $3p3d\,^3F$ term, excellent agreement is obtained between calculated and observed multiplet widths for the $3snf\,^3\mathrm{F}$ series of Al II. Other examples treated are the $^2\mathrm{P}$ series of Cu I and the $6snf\,^3\mathrm{F}$ series of Ba I. [See following Abstract.] A. H.

4931. Quantum Defect of Non-Penetrating Orbits, with Special Application to Al II. J. H. van Vleck and N. G. Whitelaw. *Phys. Rev.* 44. *pp.* 551–569, *Oct.* 1, 1933.—Modifications are given of the formula for the displacement in energy due to polarisation of the atom-core, the major cause of quantum defect in non-penetrating orbits. These are necessary if the absorption frequencies of the outer electron are not negligible compared with those of the atom-core, and they are more important for alkaline earths than alkalis since in the former the atom-core includes the inner valence electron. The modified formulæ require the evaluation of certain " centroid " frequencies, for which approximate methods are given. These methods are readily adaptable to other problems, such as the derivation of Wigner's formula for the apportionment of the dispersion *f*-sum between $l-1$ and $l+1$. With the aid of the modified polarisation formula the numbers of dispersion electrons for the resonance lines $3s-3p$ of Al III and Si IV are calculated. The values are believed to be as reliable as those given by more standard methods. The earlier absolute term values for the spectrum of Si III are shown to be all too low by $90 \pm 15\ \mathrm{cm}^{-1}$., due to improper evaluation of the series limit. The calculated values of the quantum defect of the $^3\mathrm{F}$ terms of Al II exclusive of the perturbation by $3p3d$, also the values of the interaction matrix elements $\mathrm{H}(3p3d\,^3\mathrm{F}\ ;\ 3snf\,^3\mathrm{F})$ as computed by wave functions, are found to agree within the limits of error with the values obtained elsewhere [see preceding Abstract] in connection with the multiplet anomaly. The conditions are derived under which Langer's perturbation formula is theoretically valid. A. H.

4932. Spectra of Halogen Molecules. Part I. Iodine. W. E. Curtis and S. F. Evans. *Roy. Soc., Proc.* 141. *pp.* 603–625, *Sept.* 1, 1933.—A systematic survey is being made of the existing data on the various spectra of the halogen molecules (including the inter-halide molecules), fresh data being searched for where gaps exist. Certain notable features, such as the presence of continua and of diffuse bands, are receiving special attention. Low dispersion is mainly being employed and the intensity distribution is studied microphotometrically. Only the spectrum of I_2 is here considered ; the absorption, fluorescence and emission spectra are each described in detail, and the interpretation of these various spectra is discussed at length. The chief problem in the case of the absorption spectrum is the nature of the excited states associated with the various systems. The magnitude of the dissociation energy of the products, amongst other things, leads to the conclusion that these products are probably ions, although there are other arguments against this hypothesis. The diffuse fluorescence bands (previously arranged by Kuhn into one series) are arranged into two series converging at different rates, whilst it is suggested that the further ultra-violet bands are an unusual type of extension of one of these series. It is concluded that the emission of the diffuse bands cannot immediately follow the absorption of the exciting radiation, but that a second transition intervenes. New data are also presented for the diffuse emission bands. A. H.

4933. Band Spectrum of Tin Oxide. F. C. Connelly. *Phys. Soc., Proc.* **45.** *pp.* **780–791,** *Nov.* **1, 1933.**—The spectrum of SnO has been produced by a flame source which offers considerable advantages over the arc previously used by Mahanti, and the spectrum has also been obtained in absorption. Experimental evidence has been secured confirming that the emitting molecule is SnO. The vibrational analysis of Mahanti's *A* system has been extended to $v' = 8$, and approximate values of the vibrational constants have been calculated from the band-head data. The lower electronic level of this system has been shown to be the ground state. It is doubtful whether the so-called *B* and *C* systems actually exist as separate systems. AUTHOR.

4934. Absorption of Amines in the Near Infra-Red. U. Liddel and O. R. Wulf. *Am. Chem. Soc., J.* **55.** *pp.* **3574–3583,** *Sept.,* **1933.**—Absorption coefficients were measured, and curves are given, for the absorption lying at about $1 \cdot 5\ \mu$ due to the N–H group in 34 primary and secondary aliphatic and aromatic amines, and the positions of the maxima of absorption were determined. A method is suggested for the application of such data to the detection of the presence of, and the approximate determination of the number of N–H groups present per c.c. of a solution, as well as the way in which this group is linked in the molecule. N. M. B.

4935. Investigations in the Infra-Red Region of the Spectrum. Part IX. Absorption Spectrum of Chlorine Monoxide (Cl_2O). C. R. Bailey and A. B. D. Cassie. *Roy. Soc., Proc.* 142. *pp.* 129–141, *Oct.* 2, 1933.—The infra-red absorption spectrum of chlorine monoxide, Cl_2O, has been examined between 1 and 18 μ and four bands have been isolated. Fundamental frequencies have been assigned, and the molecular dimensions approximately evaluated. The isotope effect has been considered, and is shown to account for the envelopes of certain of the bands. Cl_2O and H_2O belong to the group of molecules whose vibrations are governed by central forces, and are characterised by a vertical angle of slightly greater than 90°, and a strong resistance to angular deformation. The electronic structure of the substance is discussed. [For Part VIII see Abstract 3567 (1933).] AUTHORS.

4936. Extension of the Ultra-Violet Absorption Spectrum of Ozone towards the Longer Wave-Lengths. D. Chalonge and (Mme.) L. Lefebvre. *Comptes Rendus,* 197. *pp.* 444–447, *Aug.* 7, 1933.—The spectrum obtained with a tube 245 cm. long containing ozonized oxygen at an ozone concentration of about 20 %, using a quartz spectrograph and hydrogen tube, is recorded. Absorption is complete as far as 3385 Å. A new series of bands is reported in the region 3385–3660 Å. The absorption coefficient at 3648 Å is $0 \cdot 0025$. Preliminary detailed study of the region 3100–3660 Å, using a concave grating of dispersion $8 \cdot 4$ Å per mm., shows the existence of fine structure. H. F. G.

4937. Absorption Bands of Complex Salts. R. Samuel, A. A. H. Khan and N. Ahmad. *Zeits. f. phys. Chem.* 22. *Abt. B.* 5–6. *pp.* 431–443, *Sept.,* 1933.—The visible and ultra-violet absorption bands of 6 complex ammines involving Cr, Co and Ni and of the compounds K_2TiF_6 and K_2BeF_4 in aqueous solution are measured. The results, considered together with those of previous investigations [see Abstract 1504 (1933)], lead to general empirical rules as to the occurrence of certain bands with variation of the central atom or of the groups coordinatively bound to it.

The absorption spectra of complex salts are found to suffer characteristic modifications in the presence of neutral salts. These modifications are interpreted as due in part to a kind of molecular Stark effect and in part to a deformation effect in the field of the added ions, accompanied possibly by dehydration. A partial identification and allocation of the bands is put forward. L. A. W.

4938. New Absorption Band in Alkali Halide Crystals. R. Hilsch and R. W. Pohl. *Göttingen Nachrichten., Math.-Phys. Klasse, No.* 3, *pp.* 322–328, 1933.—A new U-absorption band is observed in alkali halide crystals, which is associated with and similar in character to the F-band, and is again produced by the wandering of electrons in the crystal. Absorption of light in the U-band causes a change in the position of the electrons which gives rise to the colour centres and the visible F-bands. The close connection between the two bands is important in relation to the problems of phosphorescence, latent photographic image, and the photoelectric conductivity. C. B. A.

4939. Extinction Curves of Alkaloids of the Quinoline Group. I. Manta. *Zeits. f. phys. Chem.* 22. *Abt. B.* 5–6. *pp.* 465–468, *Sept.*, 1933.—Of the two nuclei of alkaloid molecules of the quinine group, the substituted quinoline nucleus is the only one active in determining the appearance of the two characteristic maxima of the extinction curves, the quinuclidin nucleus playing only a subordinate part. Quinine and its derivatives show the characteristic spectrum of paramethoxylepidine, but cinchonine derivatives show that of lepidine. With cinchonine, as with lepidine, the last three of the four quinoline bands are merged into one, whereas with quinine, as with paramethoxylepidine, the first three long-wave bands are merged. Replacement of a vinyl group of the quinuclidin nucleus by a carboxyl group is without appreciable effect. The isomerism between quinine and quinidine, or between cinchonine and cinchonidine, is of but slight spectral significance. Entry of an iodoethyl group into the quinuclidin nucleus exerts little influence on the extinction curves, but the introduction of a second iodoethyl group into the quinoline resonator gives a distinct bathochromic effect. T. H. P.

4940. Absorption Spectra of Burning Hydrocarbons. A. Egerton and L. M. Pidgeon. *Roy. Soc., Proc.* 142. *pp.* 26–39, *Oct.* 2, 1933.—The character of the absorption spectra of various substances likely to be formed during the combustion of a hydrocarbon was investigated, and compared with the absorption spectra of various hydrocarbons undergoing slow combustion. The absorption spectra of the hydrocarbons during combustion exhibit three characteristics, an absorption in the far ultra-violet, bands identified with those of formaldehyde, and in the case of the higher hydrocarbons, a band with a maximum at about λ 2600. The absorption in the far ultra-violet was proved to be due mainly to the formation of acids. The absorption of peroxide compounds is in the region in which the acids absorb and it would not be possible to determine the extent to which peroxides or other substances which may be formed, take part in the absorption obtained during the hydrocarbon combustion without more elaborate methods of measurement than have been attempted in these preliminary experiments. During the induction period, no absorption is visible. For butane and the higher hydrocarbons the band at λ 2600 is the first to make appearance, and is followed by the aldehyde bands. The corresponding aldehydes on combustion do not give this band. AUTHORS.

4941. Band Spectrum of Ionised Cadmium Hydride. E. Svensson and F. Tyrén. *Zeits. f. Physik*, 85. 3–4. *pp.* 257–263, *Sept.* 4, 1933.—The band spectrum of Cd^+H is investigated with greater dispersion, and several bands, which had not previously been analysed, are arranged in the theoretical system and their constants are calculated. An approximate calculation of the work of dissociation of the normal state is given. J. E. K.

4942. Spectrum of H_2 Bands Ending on $2p^3\Pi$ Levels. Part III. O. W. Richardson and P. M. Davidson, with an Appendix by (Miss) J. Marsden and W. M. Evans. *Roy. Soc., Proc.* 142. *pp.* 40–62, *Oct.* 2, 1933.—This paper is a continuation of Part II [see Abstract 2431 (1933)], which described the band systems of H_2 coming from $3d^3\Sigma_g$, $3d^3\Pi_b$, $3d^3\Pi_a$ and $3s^3\Sigma_g$ and ending on $2p^3\Pi_{ab}$. It describes the band systems which end on $2p^3\Pi_{ab}$ and come from $4d^3\Sigma_g$, $4d^3\Pi_b$, $4d^3\Pi_a$ and $4d^3\Delta_b$. The properties and constants of all the various levels $2p^3\Pi_{ab}$, $3d^3\Sigma_g$, $3d^3\Pi_b$, $3d^3\Pi_a$, $3d^3\Delta_b$, $3d^3\Delta_a$, $4d^3\Sigma_g$, $4d^3\Pi_b$, $4d^3\Pi_a$ and $4d^3\Delta_b$ are then considered. Most of the constants are worked out from the Appendix, in which the energy levels and the intensities in the bands are shown to be in good agreement with the wave mechanics. [See following Abstract.] AUTHORS.

4943. Spectrum of H_2, $3d^1\Delta$ and $4d^1$ Levels. O. W. Richardson and P. M. Davidson. *Roy. Soc., Proc.* 142. *pp.* 63–76, *Oct.* 2, 1933.—The first part of this paper describes the bands which go down from $3d^1\Delta_{ab}$ to $2p^1\Sigma_u$ and $2p^1\Pi_{ab}$. These bands determine the $3d^1\Delta_{ab}$ levels, and complete the $3d^1\Sigma\Pi\Delta$ complex. Analogy with these 3-electronic states now enables the previously known bands from 4-electronic states to $2p^1\Sigma$ and $2p^1\Pi$ to be extended and interpreted fairly satisfactorily. The detailed spacing of the $4d^1\Sigma$, Π, Δ levels as well as the distribution of line intensities in the transitions from these levels down to $2p^1\Sigma$, Π levels is in substantial agreement with the results of the wave-mechanics theory of uncoupling. The same is true of the bands coming from $3d^1\Sigma$, Π, Δ down to $2p^1\Sigma$, Π. The existence of the bands coming from 3, $4d^1\Delta_{ab}$ levels down to $2p^1\Sigma$ has a peculiar interest since they are the only bands known in the H_2 spectrum which break the selection rule $\Delta\Lambda = 0$ or ± 1. This infraction is accounted for by the wave-mechanics theory. Various constants of the initial levels of the bands are calculated. [See preceding Abstract.] AUTHORS.

4944. Excitation of Band Systems. L. S. Ornstein and G. O. Langstroth. *K. Akad. Amsterdam, Proc.* 36. 4. *pp.* 384–390, 1933.—A theory of excitation of band systems based on assumptions similar to those of the Frank-Condon theory of emission is formulated. The relative intensities of the nitrogen bands $\lambda\lambda$ 3805, 3755 and 3710 were found to be strongly dependent on the velocity of the exciting electrons for voltages below 20 volts, but were constant above this value. The development of the rotational structure did not differ appreciably over the voltage range 12–25 volts. J. S. G. T.

4945. Absorption Spectra of Solutions of Iodine Bromide, Cyanogen Iodide and Cyanogen Bromide. A. E. Gillam. *Faraday Soc., Trans.* 29. *pp.* 1132–1139, *Sept.*, 1933.—Absorption of light by solutions of halogen compounds and cyanogen halides is of two types according to the nature of the solvent. Dichroism of I_2 solutions is attributed to solvation resulting from residual valency and persists when one atom of I is replaced by Cl, Br, or CN. A. S. C. L.

4946. Absorption of NaCl, KCl and KI in the Far Ultra-Violet. A. Smith. *Phys. Rev.* 44. *pp.* 520–523, *Oct.* 1, 1933.—With a normal incidence concave grating vacuum spectrograph with a hot spark for a light source and oiled photographic films, qualitative absorption curves for NaCl, KCl, and KI between 190 and 1550 Å have been obtained. The absorbing film of the alkali halide was distilled directly on to the ruled surface of the grating. The positions of maximum absorption as read from the three curves presented are: for NaCl, 655, 535, 350 and 890 Å; for KCl, 705, 530, 320 and 1120 Å; for KI, 825, 625 and 510 Å; all accurate to 6 %. These results are at variance with early theoretical extrapolations from the known form of the dispersion curves for rock-salt and silvite in the near infra-red. AUTHOR.

4947. Continuous Absorption Spectrum of Helium. J. P. Vinti. *Phys. Rev.* 44. *pp.* 524–528, *Oct.* 1, 1933.—The author's previous calculations [see Abstract 1046 (1933)] on dispersion and absorption in helium are extended to the continuous spectrum. By using ground state wave function due to Eckart, the intensity distribution (df/dW) within the continuum is calculated as a function of frequency. The total f-value of the continuum is found to be 1·55, which number when added to the f-values previously found for the principal series and double jumps gives a total f-value of 2·13 as against the mathematically required value 2·00. The series limit value of df/dW obtained from the formula for the continuum is 1·05, agreeing with that found by approaching the series limit from the side of the discrete spectrum. The atomic absorption coefficient μ_a of helium for the Kα line of carbon (44·6 Å) is calculated to be $3{\cdot}24 \times 10^{-20}$ cm^{-1}., agreeing fairly well with the value $2{\cdot}38 \times 10^{-20}$ cm^{-1}. found experimentally by Dershem and Schein. The results of the present paper are compared with those due to J. A. Wheeler, who used a Hylleraas function for the ground state of helium. AUTHOR.

4948. Rotation Structure and Zeeman Effect of NH-Bands. H. Batsch. *Ann. d. Physik*, 18. 1. *pp.* 81–96, *Sept.*, 1933.—The band spectrum of the NH molecule at 3360 Å and 3370 Å is investigated with a quartz spectrograph of large dispersion (5 Å per mm.). A number of weak lines, which had not been noticed previously, are discovered and interpreted as belonging partly to the (1, 1)-band and partly to a subsidiary transition. In a magnetic field the lines between the intensity maxima of the Q-branches are considerably changed, but this effect cannot be interpreted on account of the overlapping of all the branches in this region. The influence of the magnetic field can be observed at a large distance from the null-line, and is markedly different for the principal and subsidiary lines. No splitting of the principal lines is observed, but the triplet separation is changed in proportion to the square of the field-strength. The subsidiary lines show a broadening which, in agreement with theory, is directly proportional to the field-strength. J. E. K.

4949. Influence of Electric Fields on the Absorption Spectrum of Potassium. C. J. Bakker. *K. Akad. Amsterdam, Proc.* 36. 5. *pp.* 589–594, 1933.—A study is made of the effect of electric fields (up to 1600 V/cm.) upon the absorption spectrum of potassium vapour. The vapour is maintained at a temperature of 530° C., the spectrograms being obtained on a Hilger E2 spectrograph with the aid of a water-cooled hydrogen tube. It is shown that with increasing field-strength the point where the absorption series breaks down moves to longer wave-lengths. Under the influence of the electric field new absorption lines appear and these are interpreted as forbidden lines. A qualitative explanation of the results is given. [See following Abstract.] A. H.

4950. Series of Alkali Atoms in an Electric Field. E. Segrè and G. C. Wick. *K. Akad. Amsterdam, Proc.* 36. 5. *pp.* 534–542, 1933. *N. Cimento,* 10. *pp.* 211–220, *May,* 1933.—A theoretical investigation is made of the behaviour in an electric field of the potassium series 4S − *n*P, 4S − *n*S, 4*s* − *n*D, the intensities of the lines being calculated for both permitted and forbidden series. The disappearance of the last members of the permitted series is explained. The theoretical results are compared with those obtained experimentally (see preceding Abstract) and these theoretical results are found to be in close qualitative agreement with Bakker's experimental results. A. H.

4951. Raman Effect at Very Low Temperatures. G. B. B. M. Sutherland. *Roy. Soc., Proc.* 141. *pp.* 535–549, *Sept.* 1, 1933.—A new and simple apparatus is described, in which the following improvements are made. The silvered Dewar flask gives the " light furnace " effect, and facilitates long exposures by economy of liquid air. Using the downward scattered light evades all possibility of reabsorption by uncondensed vapour of the substance. The spectrograph is more completely shielded from direct light. The Raman spectra of various substances at the temperature of liquid air were photographed and their interpretations discussed. In solid nitrogen tetroxide the Raman lines are divided into two classes, corresponding to intra-molecular vibrations and intra-crystalline oscillations respectively. Liquid ozone yielded no Raman spectrum, an important negative result. Ice, at the temperature of liquid air, gave a spectrum markedly different from that at 0° C. It is not necessary to assume the presence of $(H_2O)_2$ molecules to explain this result. With solid methane, results were indecisive regarding rotation of the molecules in the crystal. In solid ammonia the crystals are probably composed of a polymer such as $(NH_3)_2$. CCl_4 shows no change from the spectrum at room-temperature. Liquid air results confirm those of earlier observers. R. M.

4952. Spectral Analysis with Glass Apparatus. W. Kraemer. *Phys. Zeits.* 34. *pp.* 714–715, *Sept.* 15, 1933.—Continuing previous work [see Abstract 2422 (1932)] the spark spectra given by beryllium-iron and nickel-iron alloys are investigated, using the previously described direct-vision instrument with glass prisms. Lines suitable for the recognition of the presence of Mg, Cu, Mn, Ti, Zr, As, Sb, Bi, Pb, P, and S are given in tabular form. L. A. W.

4953. Hydrogen Ultra-Violet Lamp. O. Darbyshire. *Journ. Sci. Instruments,* 10. *pp.* 322–325, *Oct.,* 1933.—An account is given of the method of construction of a hydrogen discharge lamp suitable for use as a source of continuous ultra-violet light in the range 3300–1850 Å. The method of mounting the lamp is such as to render it robust, stable and easily collimated when used in conjunction with a large spectrograph. AUTHOR.

See also Abstracts 4856, 4870, 4872, 4874, 4876, 4881, 4882, 4894, 4978, 4982, 4984, 4985, 5014.

VISION.

4954. Visibility of Light Signals by Day. E. Stoecker. *Gerlands Beitr. z. Geophys.* 40. 1. *pp.* 75–95, 1933.—Measurements were made of the minimum intensity of red and white test spots of 1°48′ angular diameter, at which they could just be seen against a background brightness of white light (*a*) when viewed with the naked eye, (*b*) when viewed through a red glass filter. The background brightness was varied from a value of about 0·02 to about 1·0 candle/sq.ft. The red test spot was obtained by inserting a red glass filter in the beam projecting the white light image, which formed the test spot, upon the background screen. It was found that the red test spot could be seen with a smaller beam intensity when viewed through red glass than when viewed with the naked eye. The properties of the red glass necessary to give the highest efficiency in this respect are discussed. The effect of the angular diameter of the signal spot is also dealt with. W. S. S.

4955. Visibility of Objects Illuminated by a Projector. Part III (continued). J. Rivière and Y. Rocard. *Rev. d'Optique,* 12. *pp.* 204–221, *May,* 1933.—This concluding paper of the series [see Abstract 4127 (1933)] shows by numerical examples the effect on the range of a projector of the following factors: (*a*) the position of the object in the beam, (*b*) the intensity of the beam (angular distribution of candle power kept fixed), (*c*) the lateral displacement of the observer from the projector, (*d*) the performance of the field glasses used by the observer, (*e*) the atmospheric transmission. Throughout, the object size and diffuse reflection factor were assumed to be 10·5 m. × 10·5 m. and 0·2 respectively, which correspond to the practical case of a ship approaching or receding from the projector. Numerous diagrams show clearly the influence of these different variables. W. S. S.

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X-RAYS.

4956. Comparison of X-Rays Generated by Voltages of Different Wave Form. L. S. Taylor, G. Singer and C. F. Stoneburner. *Bureau of Standards, J. of Research,* 11. *pp.* 293–308, *Aug.,* 1933. *Am. J. of Roentgenology and Radium Therapy,* 30. *pp.* 368–379, *Sept.,* 1933.—Earlier studies of the relationship between the applied voltage and the emission of general X-radiation for various voltage wave forms [see Abstract 1220 (1933)] have been extended to include generators not previously available. X-ray output per effective (rms) mA. of tube current is found for full wave and constant potential to be nearly the same at any given value of the effective (rms) voltage. For half-wave generators it is necessary to make allowance for suppressed half cycle which is useless in the production of X-rays, but which enters in the measurement of current or voltage with an a.c. meter. Current and voltage measurements with half-wave rectifiers are corrected so as to apply only during the useful portion of the cycle by the application of a factor of $\sqrt{1/2}$ and $\sqrt{2}$ to the corresponding values measured over a whole cycle. The half-wave generator then yields results similar to the other generators. The X-ray quality, as expressed by a full absorption curve, is found to be the same for all wave forms having the same effective (rms) value, and regardless of peak values. It is thus possible to express the quality of any radiation in terms of the effective voltage used to excite it. This in turn relates the quality directly to that produced by constant potential. Thus the difficulty in the use of a full absorption curve to express X-ray quality—namely, its inexpressibility as a single numerical magnitude—is overcome. All output measurements made in terms of peak voltage and average current are found to be without real significance in quality determinations. AUTHORS.

4957. Comparison of H.T. X-Ray Tubes. L. S. Taylor, G. Singer and C. F. Stoneburner. *Bureau of Standards, J. of Research,* 11. *pp.* 341–351, *Sept.,* 1933.—A comparison of the X-ray output as a function of the applied voltage has been made for 2 thin glass X-ray tubes, 5 thick glass tubes, and 1 metal-centred tube on several generators of different voltage wave form. Thin glass tubes show about 15 % greater output than thick glass tubes on constant potential, while the metal-centred tube gave about 15 % less output. At any given effective (rms) voltage, the outputs of all glass tubes on all generators were nearly the same, and equal to the output on a constant potential of the same value. Likewise, at a given effective voltage, the quality (full absorption curve) was the same for all tubes on all generators. Outputs of all tubes at a given voltage varied over a range of 25 % between tubes and between different generators. The metal-centred tube output varied widely between half and full wave rectification at equal peak voltages. The same tube, however, gave the same output at any given effective voltage supplied by any generator. AUTHORS.

4958. Direct Measurement of X-Ray Tube Voltage. F. D. Owen-King. *Brit. J. of Radiology,* 6. *pp.* 560–562, *Sept.,* 1933.—A description is given of a direct reading kilovoltmeter which can be placed on an X-ray control panel. The apparatus consists of an oil-immersed " Carbo " high resistance placed across the high tension and earthed at the centre. A small portion of this resistance near the centre is tapped off through a valve rectifier and smoothing circuit to a low reading electrostatic voltmeter. The readings of this instrument give a constant fraction of the kilovoltage across the high resistance and it can be calibrated accordingly. An accuracy of ±2 % of full scale reading is obtained.
J. E. R.

4959. Photographic Effect of X-Rays. G. W. Brindley and F. W. Spiers. *Phil. Mag.* 16. *pp.* 686–691, *Sept.,* 1933.—Using MoKα radiation and plotting photographic density, $D[=\log_{10}(L_0/L)$ where L_0 and L are respectively the intensities of light passing through the unblackened and blackened portions of the film] against (*a*) time of exposure, t, intensity, I, remaining constant, and (*b*) I with t constant, the films themselves providing the absorbing medium, it is shown that $D \propto I$ provided that D is $\not>$ 1·4.
C. A. S.

4960. Weak L-Lines of 79 Au and 74 W. H. Claësson. *Zeits. f. Physik,* 85. 3–4. *pp.* 231–239, *Sept.* 4, 1933.—Some new weak lines were obtained. The transition L_{I} to N_{IV}, as also L_{II} to N_{III}, and the presence of lines found with other elements were observed also with Au and W. New spark-lines were observed with Au. A. D.

4961. L X-Ray Spectrum of Solid Aluminium. T. H. Osgood. *Phys. Rev.* 44. *pp.* 517–519, *Oct.* 1, 1933.—The L X-ray spectrum of solid Al has been observed to consist not of sharp lines, but of a wide continuous band of radiation extending between the approximate limits 170 and 200 Å. This is in agreement with the Pauli-Sommerfeld theory of free electrons in metals. AUTHOR.

See also Abstracts 4969, 5086, 5087.

HEAT.

CALORIMETRY.

4962. Effect of Magnetic Field and of Temperature on the Specific Heats of Gases. T. Okamura. *Tohoku Univ., Sci. Reports,* 22. *pp.* 519–536, *Aug.*, 1933. *In English. Report No.* 304 *of the Research Inst. for Iron, Steel and other Metals.*—By means of the flow-method, devised by P. M. S. Blackett and others [see Abstract 2234 (1930)], the author measured the specific heats of H_2, O_2, N_2 and CO_2 with a magnetic field of about 4000 gauss, but there was no effect of the field observable. The specific heats of O_2 and N_2 were also measured in the temperature range of $20° \sim 180°$ and verified the theory of specific heats of diatomic gases at high temperatures. AUTHOR.

4963. Calorimeter for Heats of Fusion. F. D. Rossini. *Bureau of Standards, J. of Research,* 11. *pp.* 553–559, *Oct.*, 1933.—A vacuum flask with a thermoelement serves as a simple calorimeter for measuring heats of fusion quickly and economically, with an accuracy of a few per cent. The following heats of fusion (with estimated uncertainties), in *k*-cal. per mole were obtained: pseudocumene, $-44 \cdot 1°$ C., $2 \cdot 75 \pm 0 \cdot 06$; hemimellitene, $-25 \cdot 5°$ C., $2 \cdot 00 \pm 0 \cdot 05$; mesitylene ($\alpha$), $-44 \cdot 8°$ C., $2 \cdot 28 \pm 0 \cdot 06$; mesitylene ($\beta$), $-51 \cdot 7°$ C., $1 \cdot 91 \pm 0 \cdot 05$; *o*-xylene, $-25 \cdot 3°$ C., $3 \cdot 33 \pm 0 \cdot 07$; *m*-xylene, $-47 \cdot 9°$ C., $2 \cdot 76 \pm 0 \cdot 05$. Hemimellitene was found to have two transitions below the freezing point, with the following heats of transition, in *k*-cal. per mole: hemimellitene ($\gamma \rightarrow \beta$), $-58 \pm 2°$ C., $0 \cdot 28 \pm 0 \cdot 04$; hemimellitene ($\beta \rightarrow \alpha$), $-46 \pm 1°$ C., $0 \cdot 36 \pm 0 \cdot 04$. AUTHOR.

CONDUCTION.

4964. Temperature Distribution of a Gas Flowing Through a Furnace. K. F. Herzfeld. *Physics,* 4. *pp.* 362–365, *Oct.*, 1933.—In recent experiments the heat of chemical activation (formation of radicals) has been determined by measuring temperature coefficients of reaction rates of gases flowing through a furnace. To justify this procedure, an investigation is necessary to find out to what extent temperature equilibrium is reached. In this paper it is shown that the flow is laminar, and that two cases must be distinguished. Temperature equilibrium is reached throughout the flow when the pressure drop is less than $0 \cdot 003$ mm. Hg per cm. For pressure drops about ten times as high, only a thin sheet close to the wall reaches temperature equilibrium, but this fact affects only the total number of activated molecules reaching the wall, not the temperature coefficients. AUTHOR.

4965. Conduction of Heat. Part I. M. Jakob. *Die Physik,* 1. 3. *pp.* 123–130, 1933.—This paper outlines the contributions made to the subject of heat conduction during the past three years. It includes sections on the experimental and theoretical aspect of thermal conduction in gases, liquids and solids, both metallic and non-metallic, and the application of the results to technical problems. Reference is made to more than 70 papers. R. W. P.

CONVECTION.

4966. Output of Heat and Temperature Distribution of Electrically Heated Wires. A. Farkas and H. H. Rowley. *Zeits. f. phys. Chem.* 22. *Abt.B.* 5–6. *pp.* 335–343, *Sept.*, 1933.—In an investigation of the catalytic transformation of para-hydrogen at electrically heated nickel wires, the dependence of the heat output and of the catalytic activity on the temperature and pressure showed certain irregularities. Such irregularities, which occur also with platinum wires, are now found to be due, not to sudden alteration in the character of the surface or to formation of decomposition of hydride, but to the fact that the temperature distribution in the wire becomes uneven. T. H. P.

DILATATION.

4967. Thermal Expansion of Columbium. P. Hidnert and H. S. Krider. *Bureau of Standards, J. of Research,* 11. *pp.* 279–284, *Aug.*, 1933. —This paper gives the results of an investigation on the linear thermal expansion of a rod of columbium containing 0·93% tin and 0·26% iron. Data were obtained at various temperatures between − 135° and + 305° C. The following equation is given as the most probable second-degree equation for the expansion of this rod of columbium: $L_t = L_0 [1 + (7{\cdot}06t + 0{\cdot}00144t^2)10^{-6}]$. The coefficient of expansion increases regularly with temperature. From 0° to 100° C. the average coefficient of expansion is $7{\cdot}2 \times 10^{-6}$ per ° C. A table gives coefficients of expansion for various temperature ranges. AUTHORS.

4968. Thermal Expansion of Crystals with Layer Lattices. Helen D. Megaw. *Roy. Soc., Proc.* 142. *pp.* 198–214, *Oct.* 2, 1933.—The thermal expansions of certain crystals have been measured from the change in their lattice spacings as determined by X-rays. To measure the spacings with sufficient accuracy, reflections at a glancing angle of nearly a right angle have been used, where the dispersion is high. The crystals investigated all possess layer structures. Complete determinations have been made of the thermal expansions of brucite $Mg(OH)_2$, calcium hydroxide $Ca(OH)_2$, and hydrargillite $Al(OH)_3$, the last-mentioned being monoclinic; and the expansion of a mica (phlogopite) perpendicular to its cleavage plane has also been measured. The hydroxides are found to show marked anisotropy, the expansion coefficient perpendicular to the layer being greater than those in the layer. The determinations so far have been made over the range from 0° to 100° C.; it is hoped later to work down to liquid air temperatures. The values obtained for the coefficients are discussed, and compared with those of related substances. AUTHOR.

4969. Thermal Expansion of Quartz by X-Ray Measurements. A. H. Jay. *Roy. Soc., Proc.* 142. *pp.* 237–247, *Oct.* 2, 1933.—From theoretical considerations Zwicky predicted that the coefficient of thermal expansion determined visually would differ from that measured with X-rays. Measurements of Goetz and Hergenrother with single crystals of bismuth confirmed this view but Tu's measurements on rock-salt did not support it. In the present paper a description is given of X-ray powder photographs of clear colourless quartz over a range of temperature 18° to 730° C. in a high temperature camera of the Debye-Scherrer type in which the specimen is heated by surrounding furnaces. The lattice dimensions were found for each temperature observation. By using the lattice expansion of silver, and assuming the ordinary expansion law a temperature scale for the camera was obtained which when used in conjunction with the quartz spacing measurements gave (1) the $\alpha - \beta$ change point of quartz as 579° C. as compared with the acknowledged temperature 575° C., thus proving the validity of the above assumption, (2) an expansion law for each of the directions parallel and perpendicular to the principal axis which was identical with those found by using optical methods of measurement. The X-ray results indicate that for silver and quartz the coefficients of thermal expansion over the range investigated, are the same whether measured by X-ray or optical methods. R. S. R.

4970. Transformation of Solid Ammonium Chloride at about – 30° C. A. Smits and C. H. MacGillavry. *Zeits. f. phys. Chem.* 166. *Abt. A.* 1–2. *pp.* 97–112, *Sept.*, 1933.—With the object of ascertaining the nature of this change, dilatometric investigations on the ammonium chloride between – 16° and – 30° C. have been made. It is found that the transformation occurs mostly within a few hundredths of a degree, but that this sudden change in volume does not occur at the same temperature on heating as on cooling. How such a hysteresis-like behaviour could arise with ordinary polymorphic transformation processes is discussed, and it is concluded that, in all probability, the change is heterogeneous and is initiated in the homogeneous phase at lower temperatures. T. H. P.

EVAPORATION.

4971. Relations between Friction, Heat-Transition, and Evaporation. W. Findeisen. *Gerlands Beitr. z. Geophys.* 39. 4. *pp.* 356–373, 1933.—The relations between air-friction, heat transition, and evaporation at the surface of substances are discussed on the basis of the limiting layer theory. [See Abstract 1128 (1932).] Definite equations are deduced for the cases of a turbulent and a non-turbulent limiting layer, and numerical values of the exchange coefficients (applicable to the determination of the origin of mist and the psychrometer constant) deduced in both cases. C. A. S.

See also Abstracts 4718, 5093.

MELTING AND BOILING POINTS.

4972. Melting-Curve of Neon to 200 kg./cm². W. H. Keesom and J. H. C. Lisman. *K. Akad. Amsterdam, Proc.* 36. 4. *pp.* 378–380, 1933. *Comm. No. 224b from the K. Onnes Lab., Leiden*—The melting-curve of neon was determined in the range from the triple-point to 198·4 kg./cm.² and 27·42° K. A cryostat was used in which the hydrogen boils under a pressure of some atmospheres. AUTHORS.

4973. Melting Point of Carbon Tetrachloride in Relation to its Thermal Pre-treatment. W. E. Nieuwenhuis. *Zeits. f. Elektrochem.* 39. *pp.* 727–731, *Sept.*, 1933.—A series of temperature-time heating curves is given for carefully purified CCl_4, which had been previously kept at various constant temperatures (— 20°, + 17°, + 45° C.) prior to freezing. In all cases the horizontal portion of the curve corresponded with the same melting point (— 22·3°), the divergencies being of the order 0·01°. T. H. P.

See also Abstract 4963.

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TEMPERATURE, MEASUREMENT OF.

4974. Influence of Velocity of Water Current on Thermometer Readings. A. Geldbach and W. Müller. *Zeits. f. techn. Physik,* 14. 9. *pp.* 362–367, 1933.—An experimental investigation of the error in reading the temperature of a stream of liquid by insertion into it of a thermometer or thermocouple. The error in question is due to the frictional generation of heat at the surface of the measuring instrument. J. H. A.

4975. Extremely Low Temperatures. W. J. de Haas. *Nature,* 132. *pp.* 372–373, *Sept.* 9, 1933. *Naturwiss.* 21. *pp.* 732–734, *Oct.* 13, 1933.—Deals with the demagnetisation method of producing low temperatures. The older method of attaining low temperatures (by means of helium) gave 0·82° K. in 1921 and 0·71° K. in 1929. The new method in 1933 has given 0·27° K. with cerous fluoride, 0·17° K. with dysprosium ethyl sulphate and 0·085° K. with cerium ethyl sulphate. The method of measurement is described, and reference is made to the difficulty of cooling other bodies, since thermal transfer is almost eliminated. J. H. A.

See also Abstract 4898.

THERMOCHEMISTRY.

4976. Explosions of Methane and Air: Propagation through a Restricted Tube. H. Robinson and R. V. Wheeler. *Chem. Soc., J. pp.* 758–760, *July,* 1933.—An experimental investigation of flame propagation in a 10 % CH_4 — air mixture, in a tube of 1 ft. diameter by 30 m. long. The tube was provided with 11 rings, 1 ft. apart and 4 in. in internal diameter, and it was found that the flame speed in this part of the tube was greatly increased over that in the initial open part of the tube. J. H. A.

4977. Ignition of Gases. Part VIII. Ignition by a Heated Surface. C. A. Naylor and R. V. Wheeler. *Chem. Soc., J. pp.* 1240–1247, *Sept.,* 1933.—This work was carried out by similar methods and apparatus to those previously described [see Abstract 645 (1932)]. (*a*) With mixtures of CH_4 and air, the ignition temperature is lowest and the " lag " at that temperature is longest when there is excess of oxygen; whereas, with the higher paraffins the lowest ignition temperatures and the longest " lags " are obtained with excess of the paraffin. A similar behaviour follows for the lag of temperatures higher than the ignition temperature; for temperatures below the ignition temperature, the reactions of mixtures of CH_4 and air are retarded by traces of I_2, EtI, or EtBr, whereas they are accelerated with ethane. With methane, the addition at the outset of small amounts of the intermediate products of oxidation, H.CHO or CO (or both) accelerates the reactions, whereas with ethane such additions have no appreciable effect. When N_2 is present, the reactions between ethane and oxygen below the ignition temperatures are modified. (*b*) The ignition temperatures decrease as the molecular weight of the hydrocarbon increases, and the flame reactions are influenced mainly by the concentration of the combustible gas. Throughout the temperature range, the lags on ignition with propylene are longer than those of ethylene or butylene, whilst the lags with ethylene become shorter than those of butylene at 750°. It is suggested that the lower rate of reaction with propylene as compared with ethylene is due to steric hindrance. From the experiments with ethylene and air, it would seem that the most important reaction leading to the production of flame is the oxidation of the olefin to an aldehyde. H. H. Ho.

4978. Spark Ignition of Low Inflammable Gas Mixtures. Part II. Spectrographic Examination of the Ignition Spark. K. Yumoto. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 442. *pp.* 246–255, *Sept.*, 1933. *In English.*—Continuing previous work [see Abstract 1570 (1930)], a Fuess small type spectrograph is used to examine the igniting power of different types of sparks in low inflammable gas mixtures. The igniting power of a short spark (< 4 mm.) which shows a band spectrum is greater than for one which shows a spark spectrum. When the spark is long (10–12 mm.) the igniting power is not always uniform along the entire length of the spark. On portions of the spark where the heads of the nitrogen band show strongly, the igniting power is large. With a mixture of 7 % CO and 93 % O_2, with less than 0·3 % of N_2 contained as an impurity, the heads of the negative band of nitrogen show remarkably and the igniting power of the spark is greatest on the portion where these nitrogen bands show conspicuously. F. C. C.

4979. Kinetics of $H_2 - O_2$ Low Pressure Explosions. A. A. Frost and H. N. Alyea. *Am. Chem. Soc., J.* 55. *pp.* 3227–3233, *Aug.*, 1933.—The hypothesis that explosion occurs in mixtures of hydrogen and oxygen when the rate of breaking in the chain of reactions exceeds the rate of breaking of the chain, is examined experimentally. J. H. A.

See also Abstracts 4720, 4928, 4964, 4966, 4981, 4982.

THERMODYNAMICS.

4980. Origin of a Canonical System. L. S. Ornstein and W. R. van Wijk. *K. Akad. Amsterdam, Proc.* 36. 3. *pp.* 272–275, 1933. *In German.*—The transition of an arbitrary system to the canonical state by a process of approximation to the stationary state, as postulated by Gibbs in his *Principles of Statistical Mechanics*, is briefly discussed quantitatively. J. S. G. T.

4981. Entropy, Free Energy and Heat of Formation of Lithium Hydroxide and Lithium Chloride. Y. Ueda. *Tohoku Univ., Sci. Reports*, 22. *pp.* 448–474, *Aug.*, 1933. *In English.*—The thermodynamic constants for lithium hydroxide and lithium chloride have been determined by combining the experimental results obtained by the measurement of the e.m.f. of the reversible galvanic cells, with those obtained by the tensimetric and calorimetric measurements. AUTHOR.

4982. Free Energy, Entropy and Heat Capacity of Bromine and of Hydrogen Bromide from Spectroscopic Data. A. R. Gordon and C. Barnes. *J. Chem. Phys.* 1. *pp.* 692–695, *Oct.*, 1933.—The free energy, entropy and heat capacity of Br_2 and HBr have been computed for the temperature range 200–1600° K. The equilibrium constants for the reaction $Br_2 = 2$ Br, obtained from these numbers and the spectroscopic heat of dissociation, differ from Bodensten's values by more than his apparent experimental error. Calculations for the dissociation of HBr give results which agree with the e.m.f. measurements of Bodenstein and Geiger, but are in definite disagreement with the experiments of v. Falckenstein when the latter are corrected for the dissociation of bromine. AUTHORS.

4983. Molecular Theory of Gases. Part I. M. Trautz. *Die Physik*, 1. 3. *pp.* 131–140, 1933.—A very rapid survey, with Bibliographical references, of recent developments in the molecular theory of gases, both from the point of view of simple gas theory, and also taking into account the nuclear atom. J. H. A.

4984. Complex Formation due to Polarisation. Part I. System Kr – HCl. G. Glockler, C. P. Roe and D. L. Fuller. *J. Chem. Phys.* 1. *pp.* 703–708, *Oct.*, 1933.—Rare gases form compounds of a loose complex nature such as hydrates, solvates or mercury complexes. Such molecular aggregates contain a molecule of permanent dipole moment or an excited atom or molecule of dipole character as the other reaction partner besides the rare gas. The forces holding the complex molecule are the attraction between the permanent dipole and the dipole induced in the rare gas molecule due to its polarisability. Five lines of evidence are cited which indicate the formation of such complex molecules: (1) Band spectra of complex HgA and HgKr are known. (2) Rare gas hydrates have been described. (3) Isoelectronic systems similar to the rare gases have proton affinity. (4) Rare gas hydride ions have been found in the mass-spectrograph. (5) The *P-V-T* relation of gaseous mixtures show that interaction between the unlike molecules exists. The second virial coefficient is determined experimentally for Kr – HCl mixtures as a function of composition and it is shown that interaction exists between the rare gas atom Kr and the permanent dipole HCl. [See following Abstract.] AUTHORS.

4985. Complex Formation due to Polarisation. Part II. System C_3H_8 – HCl. G. Glockler, D. L. Fuller and C. P. Roe. *J. Chem. Phys.* 1. *pp.* 709–713, *Oct.*, 1933.—Molecules of saturated hydrocarbons are rare gas-like in structure and they may be supposed to behave in many respects like rare gases. They may then be expected to show complex formation with other molecules or atoms of dipole character, depending on their own polarisability [see preceding Abstract]. An experimental study of the *P-V-T* relations of the gaseous mixtures of propane and hydrogen chloride shows that interaction does indeed take place between these two types of molecules. The expression for the second virial coefficient as a function of composition of the gaseous mixtures, is shown to require an interaction term between unlike molecules in order to agree with experiment. This question of complex formation of saturated hydrocarbons is further discussed on the basis of Brönsted's theory of acids and bases. AUTHORS.

4986. Binary Systems in Two Phases. I. HCl – Kr. II. HCl – C_3H_8. G. Glockler, D. L. Fuller and C. P. Roe. *J. Chem. Phys.* 1. *pp.* 714–716, *Oct.*, 1933.—The *P - T - X* relations of the binary mixtures HCl – Kr and HCl – C_3H_8 have been determined. Retrograde condensation was observed with all mixtures studied. Not more than one liquid phase was found for any of the mixtures. [See two preceding Abstracts.] AUTHORS.

See also Abstracts 4712, 4717, 4721, 4751, 4844, 4979.

ACOUSTICS.

4987. Diffraction of Sound Waves by a Cylindrical Obstacle. T. Kuyama. *Phys. Math. Soc. Japan, Proc.* 15. *pp.* 369–370, *Sept.,* 1933. *In English.*—Some calculated results of the diffraction of sound waves by a cylindrical obstacle, when the radius of the cylinder is comparable with the wave-length, are shown graphically. AUTHOR.

4988. Strike Note of Bells. E. Meyer and J. Klaes. *Naturwiss.* 21. *pp.* 697–701, *Sept.* 29, 1933.—A special bell was investigated which had a strike note about 530 and a second partial of frequency about 495. The bell was struck on the sound bow and a sound spectrum taken by a search-tone method. The spectrum does not contain the strike note, and it is concluded that the strike note has no objective existence, but arises as a difference-tone between two partials, in this case the 5th (1073) and 7th (1605). The duration of the strike note was 1·2 seconds. It has this advantage over other possible difference-tones that it harmonises best with certain partials of the bell. These conclusions are supported by a statistical survey of the strike notes of a large number of bells. G. E. A.

4989. Resonance in Coupled Pipes. A. E. Bate. *Phil. Mag.* 16. *pp.* 562–574, *Sept.,* 1933.—The natural frequency of a resonator consisting of two coaxial cylindrical pipes of different diameters joined end to end, and closed at the larger end, was investigated theoretically by Aldis. The writer using a series of such resonators closed at *either* end, found that the experimental results agreed closely with those obtained by Aldis's formula. Further, the relationship is established between this formula and an empirical expression given by Cermak for this type of resonator, but with pipes equal in length. AUTHOR.

4990. Vibrations of Pianoforte Sound-Board. L. D. Mahajan. *Indian Journ. Phys.* 7. *pp.* 539–548, *April* 20, 1933.—The vibrations of different parts of the pianoforte sound-board have been studied by a method described by the author in an earlier paper [see Abstract 3194 (1930)]. It is found that the prominent harmonics present in the vibration curves of any one point persist in the curves for other points lying at various places on the sound-board. It is concluded that the entire sound-board vibrates as a whole inasmuch as the vibrations of all the ribs constituting the board are exactly similar in nature. It is, however, noted that the amplitudes of the various harmonics vary from rib to rib; ribs of larger length produce higher harmonics of prominent amplitude whereas in the smaller ribs the higher harmonics disappear. AUTHOR.

4991. Theory of Pianoforte. S. Sawade. *Zeits. f. techn. Physik,* 14. 9. *pp.* 353–362, 1933.—A review of previous work on the struck string and the quality of tone attained is followed by a description of the apparatus used for the spark photography of the process of percussion. Various constructions are described for micro-percussion, and it is shown how, with micro-hammers, double blows on the string can be avoided. An investigation is made on the effects of the mass of hammer, mass of string, point of percussion and area of hammer on the time of contact between hammer and string. For a hard hammer there is satisfactory agreement with Kaufmann's theory. Kaufmann's observation, that soft hammers have a longer time of contact than hard hammers of the same weight, is extended, and the time of contact is found to be greater the greater the weight of the hammer relative to that of the string, and the farther the point of percussion is from the end of the string. In percussion with a soft hammer, a quantitative theory is given on the transformation of the energy of the hammer into energy of the string, and experiment confirms the theory. For a certain position of the hammer the efficiency of percussion is a maximum, and this position does not in general coincide with that which gives best tone quality. On increasing the ratio mass of hammer to mass of string, the position is displaced towards the end of the string. This explains why, in the treble of a piano, the point of percussion is very close to the end of the string. The differences in the character of the tones of grand and electrical pianos are elucidated by oscillograms of the fading away of the tones. In the grand piano the coupled vibrations of string and sounding board have a strong influence on the whole course of the dying tone. In the bass the tone intensity only reaches a maximum after a certain interval, and over the whole range of notes the damping follows different exponential courses. The separate overtones die out in different times, so that the percentage composition of overtones varies irregularly with the time, an effect which the piano builder calls " singing." In the electrical piano the feeble damping action of the sounding board can be augmented by artificial damping, and " time damping " gives an approach to the desired effect. The change of quality in a dying note in the ordinary piano can hardly be imitated by purely electrical means. G. E. A.

4992. Propagation of Sound in Nitrogen Tetroxide. W. T. Richards and J. A. Reid. *J. Chem. Phys.* 1. *pp.* 737–748, *Oct.*, 1933.—The absorption of sound in N_2O_4 is discussed, and it is pointed out that absorption measurements should be capable of distinguishing whether a given absorptive region is due to failure of the dissociation reaction or of the heat capacity to follow the adiabatic cycle of the sound wave. Appropriate expressions for the absorption are derived from Einstein's theory, and are briefly discussed. An experimental method of determining the absorption maximum is described in which the temperature is varied at constant pressure and frequency. Under these conditions the acoustical variables are maintained very nearly constant. An attempt to detect the absorption maximum at 450·1 kc. and 260 mm. in N_2O_4 was unsuccessful, because of the inaccuracy of the absorption measurements. It is concluded that dispersion measurements provide at present an easier and more accurate method of investigating the acoustical properties of rapidly dissociating gases than measurements of the absorption coefficient. Occasion is taken to discuss the tube corrections applied to the previous dispersion measurements at greater length than was before considered necessary. Several corrections to the previous work [see Abstract 1571 (1933)] are also appended. AUTHORS.

4993. Reflecting Power of the Earth's Surface for Sound Waves Incident Normally. F. Eisner and K. Krüger. *Hochfrequenztechn. u. Elektroakustik*, 42. *pp*. 64–67, *Aug.*, 1933.—Sound waves of frequency 2900 were sent out from a whistle on board an airship and were received at the other side of the gondola by a microphone tuned to the whistle. The

received sound was amplified by a 3-valve apparatus and the intensity recorded by an impulse-measuring instrument. The reflecting power of water being taken as unity, that of thin ice is 1·07, of meadow land 0·49, and of pine woods from 0·21 for young trees to 0·45 for full-grown trees. With varying nature of country, the height above the ground for a given intensity of echo varies as the square root of the reflection coefficient.
G. E. A.

4994. Frequency Modulated Signals in Reverberation Measurements. F. V. Hunt. *Acoustical Soc. of America, J.* 5. *pp.* 127–138, *Oct.,* 1933.—A point-by-point curve tracer, similar to that described by Norris and Andree but modified to permit variations in sound intensity to be measured by a substitution method, is employed to study the reverberant decay of pure tones and tones having various degrees of frequency modulation (so-called " warble " tones). Straight lines (db *vs.* time) are fitted to the decay curves by an analytic process which is described. The deviations of individual points from the best straight line are computed and found to fall into systematic time patterns which are critically dependent upon frequency and upon the position of either microphone or loudspeaker in the sound chamber. Major characteristics of the time-deviation pattern usually persist as the frequency modulation of the source is increased, but the magnitude of the deviations may be reduced considerably. An approximate relation between the average deviation and the fractional frequency modulation ($\Delta f/f$) is given. In view of the frequency selectivity of absorption, 20 % is recommended as a satisfactory degree of warble for all frequencies. It is pointed out that large errors in the measured decay rate may arise from an ordered arrangement of the time-deviation pattern. An evaluation of these errors in terms of the average deviation of the experimental points from linearity is given which is believed to be applicable generally to any sound decay measurements. It is concluded that the warble tone is distinctly useful for securing decay curves that are more nearly linear, but that space effects may still exist which are capable of introducing serious errors. AUTHOR.

4995. Sound Track of the Vowel *ah*. E. W. Scripture. *Nature,* 132. *pp.* 486–487, *Sept.* 23, 1933.—A copy is given of the track registered by a loop oscillograph on a sound film. It is marked off into short bits corresponding to the jets of air from the glottis. The vowel track disposes of the overtone theory of vowels. G. E. A.

4996. New Method of Frequency Analysis and its Application to the Investigation of Aircraft Noises. F. Eisner. *Hochfrequenztechn. u. Elektroakustik,* 42. *pp.* 53–64, *Aug.,* 1933.—A process is described for analysing periodic a.c. voltages which involves the use of two search-tones and is similar to that known in h.f. technique as superheterodyne reception. Suppose that a tone-mixture is to be analysed whose highest partial has frequency a. To this sound is added a pure sine wave the frequency of which is slowly changed from a to $2a$. If the tone-mixture contains a partial of frequency x, a difference tone a will be observed when the search-tone has frequency $a + x$. The resulting current flows through a filter which passes frequencies in the range $a + f_0$. The current behind the filter gives maximum deflection when its frequency is a. The current which emerges from the filter is now mixed with that from a generator of constant frequency $a - f_0$ and a new difference tone is produced with frequency which changes from 0 to $2f_0$ as the search-tone varies by $2f_0$. The maximum of this second difference tone is at f_0, and is produced in a resonance circuit of low frequency and narrow range, the resonant member being a mechanical oscillator. A diagram is given of the arrangement of generators, analysers and filters, and the paper is illustrated with photographs of analyses. To shorten the process and to make it possible to analyse events of short duration, it is suggested that the photography and the analysis should be done separately. [See also Abstract 317 (1933).] G. E. A.

4997. Intensity of L.F. Sounds Close to a Metal Airscrew. C. F. B. Kemp. *Phys. Soc., Proc.* 45. *pp.* 727–733, *Sept.* 1, 1933.—A condenser transmitter and continuously recording kathode-ray tube have been used to obtain the wave-form of the sound from a metal airscrew operating at zero rate of advance. Fourier analysis has been applied to records taken at various distances up to 300 ft. from the airscrew and the rate of decay of intensity has been determined for the first three harmonics. At distances greater than 100 ft. the inverse-square law of distance has been found to hold, but at nearer points the rate of decay is not constant and varies in a complicated manner. The average rate of decay is less than that given by the inverse-square law, a result not in concordance with recent determinations by Obata, Yosida and Morita. An explanation of this difference is given. AUTHOR.

4998. Silencing Aircraft. A. H. Davis. *Engineer,* 156. *p.* 316, *Sept.* 29, 1933. *Extracted from the Aeronautical Research Committee's R. and M., No.* 1542.—In 1929 a Sub-Committee was formed by the Aeronautical Research Committee to investigate the subject of aircraft noise. Various aspects of the work have received attention, and the present paper is an attempt to summarise the general conclusions in a form suitable for the aircraft industry, without reference to the result of the investigations themselves. AUTHOR.

4999. Sensitivity of Finger-Tips to Vibrations at Various Frequency Levels. L. D. Goodfellow. *Frank. Inst., J.* 216. *pp.* 387–392, *Sept.,* 1933.—Twenty persons were tested with vibrations communicated to the finger-tip by a teletactor which consists of two plates of Rochelle salt separated by mica. The crystals are clamped at three corners, and the fourth corner is free to vibrate with the oscillations of the current. The frequencies employed were from 64 by octaves to 8192, and for these the intensity thresholds were determined for each observer. Data are given for the sensitivity of touch in decibels below the sensitivity of the normal ear. As examples: at 64 d.v. per sec., a tone which can be just barely heard must be increased 41 db. to be perceptible to the finger-tip, whereas a tone of frequency 2048 must be increased 115 db. to be detected by the sense of touch. [See also Abstract 4183 (1933).] G. E. A.

ELECTRICITY AND MAGNETISM.

ALTERNATING-CURRENT NETWORKS.

5000. Determination of a Mutual Inductance in Terms of the Self-Inductance of its Components. L. M. Chatterjee. *Phys. Zeits.* 34. *pp.* 711–712, *Sept.* 15, 1933.—On the basis of results given by Maxwell, the expression $M^2 = S^2L_1^2 - P^2L_2^2/S^2L_1/\Delta L_2 - P^2L_2/\Delta L_1$ is derived, where M is the mutual inductance while P and S are the resistances and L_1 and L_2 are the self inductances of the primary and secondary respectively : ΔL_1 and ΔL_2 are the changes in L_1 and L_2 according as the linked circuits are on open- or short-circuit. The measurements are carried out on a bridge with a.c. and a telephone and the results are in good agreement with determinations made by other methods. F. C. C.

See also Abstracts 4996, 5067.

CONDUCTION AND DISCHARGE IN GASES.

5001. Sparks in Air of Atmospheric Pressure. G. Holst. *K. Akad. Amsterdam, Proc.* 36. 3. *pp.* 271–272, 1933.—The mechanism of the production of sparks in air at atmospheric pressure investigated by Strigels [see Abstract 5191 (1932)], who found that every electron leaving the spherical kathode used produces a spark, is discussed. J. S. G. T.

5002. Maintenance Potential of Glow Discharge in Air. E. L. E. Wheatcroft. *Leeds Philosoph. and Lit. Soc., Proc.* 2. *pp.* 483–487, *July,* 1933.—Experiments are described which show that the potential across the Crookes dark space in an air discharge between plane electrodes is a function of the product of the pressure and the distance over which the potential is measured, the current being constant. When the space is reduced so as to contract the dark space, it is found that the potential needed to maintain a current differs little from the striking potential. H. M. B.

5003. Glow Discharge over a Wide Pressure Range. A. v. Engel, R. Seeliger and M. Steenbeck. *Zeits. f. Physik,* 85. 3-4. *pp.* 144–160, *Sept.* 4, 1933.—The kathode current density of a normal glow discharge between Cu electrodes in air and H_2 was determined over a pressure range from 10 to 760 mm. of Hg and the results were compared with those of Thoma and Heer [see Abstract 324 (1933)]. The dependence of the normal current density upon the pressure is calculated from an argument based on analogy and the effect of rise of temperature is shown to be important at the higher pressures. Consideration of different experiments on the change of the glow into the arc discharge according to the type of kathode cooling (cold liquid, rotating kathode) show that no decision can be drawn between the relative effects of thermal and autoelectronic liberation of electrons at the kathode. Rotating mirror photographs of an a.c. glow discharge at different current strengths allow the change from zero current up to the arc discharge to be studied. F. C. C.

5004. Effect of Inductance on the Intermittent Glow Discharge. W. E. Kock. *Physics,* 4. *pp.* 359–361, *Oct.,* 1933.—The insertion of an inductance in the condenser arm of an intermittent glow discharge circuit

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was found to affect the characteristics of the oscillations. The voltage-frequency curve was noticeably altered, the wave form of the voltage across the condenser became sinusoidal and other new wave forms were introduced. Within a certain range, the frequency of oscillation was practically independent of the voltage, resistance or tube characteristics. Various applications are suggested. AUTHOR.

5005. Electrical and Optical Measurements in H.F. Gas Discharges. L. Rohde and H. Schwarz. *Zeits. f. Physik*, 85. 3–4. *pp.* 162–171, *Sept.* 4, 1933.—The behaviour of h.f. gas discharges is discussed and investigated. At very high frequencies the resistance of the gas discharge can be considered constant over a cycle. The current-voltage characteristic of the effective current is similar to that of the positive column in d.c. discharges. It is shown that a circuit containing a h.f. gas discharge can be represented by an equivalent circuit which will account accurately for the behaviour of the discharge. The candle power and wattage of the discharge were measured for various currents up to 1 ampere. The dependence of the candle power on gas pressure and current density was also investigated, and it was found that the candle power per sq. cm. was approximately proportional to the square root of the current density. J. E. R. C.

5006. Excitation Probabilities of He, A and Ne at Zero Scattering Angle. J. E. Taylor and R. Whiddington. *Leeds Philosoph. and Lit. Soc., Proc.* 2. *pp.* 417–419, *July*, 1933.—As in the previous results with He [see Abstract 3021 (1933)], the probability curve for A is linear but it rises more steeply. This is in accordance with expectation since there are two likely singlet transitions. With Ne, however, there is a marked hump at about 150 volts, suggesting the possibility of a triplet transition. The absolute probabilities for He are in approximate agreement with those computed from the theory of Massey and Mohr [see Abstract 3800 (1933)]. F. C. C.

5007. Energy Losses of Slow Electrons in Nitrogen. G. W. Brindley. *Leeds Philosoph. and Lit. Soc., Proc.* 2. *pp.* 420–426, *July*, 1933. —Using Whiddington's method, the energy losses of electrons passing through nitrogen are shown to occur at $8\cdot6$, $12\cdot2_5$, $12\cdot9$ and $14\cdot9$ volts, the second and third losses being much the most probable. On comparison with spectroscopic data, these results agree with the singlet levels *a* ($8\cdot5$), *b* ($12\cdot52$), and b^1 and *c* ($12\cdot79$ and $12\cdot88$). The $14\cdot9$ volts loss agrees with the D triplet level if Sponer's value of 13 volts is assumed for the C level, but if a lower value is assumed, there is no obvious explanation. The present results do not agree with Rudberg's results for nitrogen. F. C. C.

5008. Nature of Gas Ions. O. Luhr. *Phys. Rev.* 44. *pp.* 459–462, *Sept.* 15, 1933.—The mass of gas ions formed in a glow discharge and aged up to 10^5 impacts was determined by a Dempster type of mass-spectrograph. In hydrogen it is found that the primary ion, H_2^+, changes within a few thousand collisions to H_3^+, together with small quantities of H^+. The nitrogen primary ions, N^+ and N_2^+, attach to neutral molecules in about 10^5 impacts to form N_3^+ and N_4^+. In pure oxygen the ions consist almost entirely of O_2^+ with small quantities of O^+. Air ions include all possible nitrogen and oxygen ions, the aged air ions consisting principally of N_3^+, N_4^+ and O_2^+ together with the oxides of nitrogen. Charges are transferred from O_2^+ to NO, NO_2 and N_2O. Water vapour is particularly active in acquiring a charge by transfer and H_2O^+ ions may be most numerous in apparatus not baked out. No heavier clusters than N_4^+ were observed. No negative ions were observed. Some conclusions published in earlier work must be revised. [See Abstract 1714 (1932).] AUTHOR.

5009. Passage of Positive Ions through Gases. H. S. W. Massey and R. A. Smith. *Roy. Soc., Proc.* 142. *pp.* 142–172, *Oct.* 2, 1933.—The collisions with gas atoms of slow positive ions (velocity less than the orbital velocity of atomic electrons) are discussed in terms of a quantum mechanical theory of collisions. This theory treats the relative motion of the centres of mass of the ions and atoms as a perturbation, and is applied to both elastic and inelastic collisions. It is found possible to correlate most of the experimental results in terms of the theoretical formulæ, and good agreement is found between observed and calculated collision cross-sections. The case of collisions of ions with similar atoms is also considered in detail, taking account of nuclear symmetry. AUTHORS.

5010. Electron-Ray Oscillograph. J. Dantscher. *Zeits. f. techn. Physik*, 14. 9. *pp.* 337–341, 1933.—The paper commences with a brief summary of the many forms of kathode-ray oscillograph which have developed from the original form of Braun tube. References are also given to the various methods of producing a linear time scale for the time axis of the oscillograph record. The author describes the new "A.E.G. electron-ray-oscillograph" with its associated circuits. Means for producing a linear time scale synchronised with the periodic oscillation to be recorded are given and various typical oscillograph records are reproduced. The paper concludes with a list of possible applications of this form of oscillograph and timing circuit. A. B. W.

5011. Electron Current Density in Kathode-Ray Tubes. F. Malsch. *Arch. f. Elektrot.* 27. *pp.* 642–656, *Sept.* 1, 1933.—The electron current distribution in the kathode beam of a kathode-ray discharge tube, as dependent on the potential, current, tube dimensions, kathode form and age, was investigated experimentally. The relation of the pressure in the discharge tube to the above quantities was also investigated and the results are presented in graphical form. The current distribution in a beam concentrated by means of a long or a short coil was found for a large number of particular cases. It is shown that the current density that may be reached in this way is very high. For a total current of 1 mA. and 40 kV exciting potential the current density may have a value as high as 20 mA./mm². A comparison is made of the various types of discharge tube used in kathode ray oscillography, particularly as regards recording speed and thickness of the trace on the oscillogram. It is concluded that the type of tube using a pre-concentration coil is by far the best in both respects. A. W.

5012. Current Measurement by means of the Kathode-Ray Oscillograph. A. Matthias, B. v. Borries and E. Ruska. *Zeits. f. Physik*, 85. 5–6. *pp.* 336–352, *Sept.* 14, 1933.—A new form of current measuring device is described in which a specially designed coil carrying the current is arranged to deflect the kathode-ray stream in an oscillograph. The first part of the paper deals mathematically with the questions of homogeneity of the magnetic field produced by the coil, the accuracy of measurement of current, and with the inductance of the coil. The coil, of pyramid form, is arranged symmetrically with respect to the axis of the oscillograph and consists of one or more turns according to the sensitivity required. When a single turn coil is used, apertures are made in the ends of the loop (of flat strip) to permit the traverse and deflection of the kathode rays. The inductance of the coils employed is of the order of 10^{-8} henry. A number of oscillograms are reproduced in the paper to illustrate the application of the method as a current measuring device for oscillations of very high frequency. The records show the form of the current oscillations at frequencies of the order of 10^6 p.p.s., the currents varying over a range 0 to 10 amperes or thereabouts. A. B. W.

5013. Electron Microscope Pictures with Secondary Electrons. M. Knoll and G. Lubszynski. *Phys. Zeits.* 34. *pp.* 671–674, *Sept.* 1, 1933.—With a new form of electron lens of wide aperture it has been found possible to obtain an undistorted picture on a luminescent screen of the secondary electron emission from a piece of wire gauze. Using the primary electrons an image of the gauze appears as a system of dark lines on a lighter background, while the secondary electron emission gives a system of bright lines on a darker background. It appears that under certain conditions each wire of the net acts as a small electron lens with a definite focal length. A series of quantitative measurements on the secondary emission of metals and insulators will be undertaken with the method here described. A. W.

5014. Reactions of the Hydroxyl Radical in the Electrodeless Discharge in Water Vapour. W. H. Rodebush and M. H. Wahl. *J. Chem. Phys.* 1. *pp.* 696–702, *Oct.*, 1933.—In a study of the reactions occurring in the electrodeless discharge in water vapour consistently high yields of H_2O_2 were obtained. A number of reactions have been studied and by a process of elimination a mechanism for the formation of H_2O_2 from hydroxyl has been suggested. In the course of some spectrographic investigations of the electrodeless discharge in water vapour some new bands, with heads at 3564 and 3328 Å, were observed which are probably due to an ionised hydroxyl. These bands were not present in the uncondensed electrode discharge but appeared in the condensed electrode discharge at low pressures. AUTHORS.

5015. Wilson Chamber as a Counting Apparatus for α- and H-Rays. R. Trattner. *Akad. Wiss. Wien, Ber.* 142. 2*a*. 3–4. *pp.* 155–167, 1933.—Using a small expansion chamber of the Shimizu type, the dependence of the yield of tracks of different kinds of ionising rays upon constants of the apparatus is determined. The number recorded is different for α- and H-rays and also depends upon the method of production of the latter. For α-rays and for natural H-rays from paraffin wax or H-rays produced by the disintegration of Al by α-ray bombardment, the number increases with the expansion number up to 70 per min., after which it becomes constant. In all cases the number increases nearly linearly with the expansion ratio but much more rapidly for α-rays. The effect of room-temperature from 6° C. to 23° C. is very small. The behaviour with H-rays produced by neutron bombardment (Po-Be source) of gelatin is quite different and shows a directional effect, the number recorded of those released in a forward direction increasing continuously up to and beyond an expansion number of 110 per min., while the "backwards" number reaches a constant value after an expansion number of 60 per min.

Similar differences are shown in the dependence upon expansion ratio and while the recorded backwards number appears to be independent of temperature, the forwards number decreases as the temperature increases, reaching a constant value at about 20° C. Considering the number of rays recorded by a tube counter as a standard, the yields of the expansion chamber are estimated at 15 % for α-rays and at 10 % and 5 % for natural H-rays and those obtained from Al respectively. F. C. C.

5016. New Type of Expansion Apparatus. C. T. R. Wilson. *Roy. Soc., Proc.* 142. *pp.* 88–91, *Oct.* 2, 1933.—A new type of expansion apparatus is described, which is more easily constructed than the usual form, and is less restricted as to the size and shape and position of the cloud chamber. AUTHOR.

See also Abstracts 4713, 4831, 4835, 4882, 4944, 4978, 5051, 5057, 5031.

CONDUCTION IN SOLIDS AND LIQUIDS.

5017. Standard-Cell Comparator. H. B. Brooks. *Bureau of Standards, J. of Research,* 11. *pp.* 211–231, *Aug.*, 1933.—The standard cell plays a very important rôle in the maintenance of the electrical units and in correlating the units of the various national laboratories. Modern standard cells have attained such a high degree of reproducibility and permanence as to warrant the use of apparatus of the utmost precision and reliability in their intercomparison. The paper describes a new potentiometer developed especially for this purpose. Although it actually measures the small difference between the known e.m.f. of a reference cell and that of the cell under test, it contains a simple mechanical computing feature which automatically adds this small difference algebraically to the e.m.f. of the reference cell and thereby indicates directly the value of the e.m.f. under measurement. The design of the instrument is such that no readjustment of its coils will be required when the impending changes in the ohm and the volt are accomplished. The new instrument has been given the distinctive name, "standard-cell comparator." AUTHOR.

5018. Thermocouple Potentiometer. A. Egerton and A. R. Ubbelohde. *Journ. Sci. Instruments,* 10. *pp.* 310–311, *Oct.*, 1933.—The instrument described is intended to combine sensitivity with a large range of temperature for thermocouple measurements. The principle of the method is to oppose the e.m.f. of the couple by one nearly equal, thus enabling a millivoltmeter to be read directly in ranges of 100° C. between − 100° C. and + 1200° C. AUTHORS.

5019. Improved D.C. Amplifying Circuit. L. A. DuBridge and H. Brown. *Rev. Sci. Instruments,* 4. *pp.* 532–536, *Oct.*, 1933.—The sensitivity of d.c. amplifying circuits with FP-54 tubes is limited by the stability which can be obtained. In single-tube circuits it is necessary to balance out fluctuations caused by changes in battery e.m.f. and in filament emission. Soller's circuit [see Abstract 5291 (1932)] for balancing out e.m.f. changes has been studied in detail and a modified circuit has been developed in which the adjustments are less critical and which allows balancing out of changes in filament emission also. The latter is accomplished by balancing the plate current against the current to the space-charge grid. Details of construction and manipulation of the new circuit are given, as well as data on its stability. AUTHORS.

5020. Theory of the Relation between Pressure and Conductivity of Metals. W. Kroll. *Zeits. f. Physik*, 85. 5–6. *pp.* 398–402, *Sept.* 14, 1933.—The pressure effect on electric conductivity is examined by Bloch's theory. By the assumption of Fermi's potential as a point in a crystal lattice, the relation is easily obtained; the simple case in which the potential depends only on the pressure is considered. If the compressibility is small the agreement with P. W. Bridgman's experimental results is good. A comparison table is given for gold, silver and lithium. H. M. B.

5021. Contact Rectifier. M. Anastassiadès. *Comptes Rendus*, 197. *pp.* 677–678, *Oct.* 2, 1933.—The rectifying properties of a system of two successive layers of CuS and Cu_2S pressed between two pure copper electrodes are discussed. The voltage-current curves in the direction CuS–Cu_2S are regular parabola and in the opposite direction almost straight lines. Of the three contact surfaces, that of Cu–Cu_2S is considered to be the most important. The current passes more easily in the direction CuS–Cu_2S. For low a.c. voltages the current is rectified in the reverse direction. An explanation of this is given. R. L.

5022. Supraconductivity of Aluminium. W. H. Keesom. *K. Akad. Amsterdam, Proc.* 36. 4. *pp.* 381–383, 1933. *Comm. No.* 224c *from the K. Onnes Lab., Leiden.*—It was found that aluminium becomes supraconductive at 1·14° K. AUTHOR.

5023. Magnetic Interaction of Metallic Electrons. Criticism of Frenkel's Theory of Supraconductivity. H. Bethe and H. Fröhlich. *Zeits. f. Physik*, 85. 5–6. *pp.* 389–397, *Sept.* 14, 1933.—An exact analysis by Hamiltonian functions and the quantum theory shows that contrary to the conclusion to be drawn from Frenkel's theory [see Abstract 3764 (1933)] the magnetic interaction between electrons has no influence on the theory of supraconductivity and only, by an acceleration of the electron current, does the ordinary self-inductive effect appear in the macroscopic state. H. M. B.

5024. Resistance of Palladium Wire Containing Hydrogen. D. P. Smith. *Zeits. f. Elektrochem.* 39. *pp.* 743–744, *Sept.*, 1933.—The paper is a reply and criticism to a paper bearing a similar title by Knorr and Schwartz [see Abstract 3167 (1933)]. The qualitative and quantitative conclusions of these authors is challenged. F. J. B.

5025. Conduction in Inorganic Materials Having Electron Conductivity. W. Meyer. *Zeits. f. Physik*, 85. 5–6. *pp.* 278–293, *Sept.* 14, 1933.—The specific resistance R, of a number of metallic oxides has been measured. The relation $R = ae^{-b/T}$, where T is the temperature and *a* and *b* are constants was verified in all cases except where structural change of the compound took place within the range of temperature used in the investigations. R was found to depend very largely upon the gas content of the specimen. Measurements were carried out *in vacuo* and in the presence of various pressures of CO_2, air, N_2 and H_2, and the constants *a* and *b* of the formula obtained under different pressures. In general, for the same oxide under various conditions, *b* is greater when R is greater, both *b* and R increasing with the gas content. A serious difficulty thus arises when determining the specific resistance of this class of compound. Measurements on carefully degassed oxides show that, in general, the constant *b* increases almost linearly with R. A theoretical discussion is appended. J. E. R. C.

5026. Conductivity of Tetramethylammonium Salts in Methyl and Ethyl Alcohol. T. H. Mead, O. L. Hughes and H. Hartley. *Chem. Soc., J. pp.* 1207–1214, *Sept.*, 1933.—The electrical conductivities of seven tetramethylammonium salts have been determined in methyl alcohol at 25° over the range $0 \cdot 0001N$–$0 \cdot 0015N$. Similar measurements have been made for five of these salts in ethyl alcohol. The mobility of the tetramethylammonium ion is 70·1 in methyl and 28·3 in ethyl alcohol. The deviations of the tetramethylammonium salts from the Debye-Hückel-Onsager equation are considerable in both alcohols, indicating appreciable ionic association, and in both they are greater than those of the corresponding tetraethylammonium salts. AUTHOR.

5027. Conductivity of Weak Electrolytes and Glycerin Solutions. B. G. Whitmore. *Phys. Zeits.* 34. *pp.* 649–659, *Sept.* 1, 1933.—Using a wave-length of 75 cm. determinations have been made of the electrical conductivity of several weak electrolytes and glycerin solutions. At this high frequency most of the electrolytes show an increase in conductivity which is of the order given by the Debye-Falkenhagen theory. Solutions of $ZnCl_2$ and ZnI_2 in acetone, however, give large deviations from the theoretical values which may be due to anomalous dipolar absorption of undissociated molecules, probably associated with molecules of the solvent. The anomalous absorption of glycerin is found to be lowered by the addition of $Ca_2Fe(CN)_6$, the decrease apparently depending on the valency of the added salt. The possibility of this effect being the result of " ionic-saturation " is discussed. R. W. P.

5028. Dependence of Dispersion of Conductivity on Temperature. H. Geest. *Phys. Zeits.* 34. *pp.* 660–671, *Sept.* 1, 1933.—The dispersion of the electrical conductivity of solutions of $MgSO_4$, $La_2(SO_4)_3$ and $Ca_2Fe(CN)_6$ has been studied over the temperature range 0 to 50° C, a wave-length of 8m. being used. A decrease in the dispersion effect is found to occur with increase in temperature, which is greater for higher valencies, and for $MgSO_4$ and $La_2(SO_4)_3$ is in quantitative agreement with the theory of Debye and Falkenhagen. $Ca_2Fe(CN)_6$ is found to undergo chemical change at the higher temperatures. R. W. P.

5029. Conductivity of Uni-Univalent Electrolytes at High Frequencies. E. Glowatzki. *Ann. d. Physik*, 18. 2. *pp.* 217–232, *Sept.*, 1933.—The comparative method previously used by Zahn and Rieckhoff for measuring the variation in the h.f. conductivity of electrolytes has been improved so that changes of only 0·05% can be accurately measured. This modified method is applied to univalent electrolytes. Using a frequency of $3 \times 10^8 \sim$ the conductivities of HCl and NaCl solutions have been compared with KCl, which was first tested against $MgSO_4$. After making allowance for the change in dielectric constant with concentration the results are found to be in good agreement with the theory of Debye and Falkenhagen. R. W. P.

5030. Electrical Properties of Calcite. S. Shimizu. *Tohoku Univ., Sci. Reports*, 22, *pp.* 570–598, *Aug.*, 1933.—It is a well-known fact that Iceland calcite shows a remarkable character for " the condensed polarisation " while such a property is not found in the calcite of Canada. The following electrical properties of the calcite in Japan with specimens cut parallel and perpendicular to the *c*-axis were examined : (1) the residual charge of the calcite, (2) the effect of the previously applied potential on the electrical conductivity, (3) the variation of the conductivity with the temperature, especially in a range from 500° C. to 900° C., at which, a dissociation phenomenon begins. It was concluded from the measurements of the residual charge and its recovery time, that there is no condensed polarisation in the calcite of Japan. The apparent conductivity is affected seriously by the previously applied potential, but the recovery time of the conductivity is a little small compared with that of quartz cut perpendicular to the *c*-axis. It was also concluded that the electrical conductivity varies remarkably in a range of temperature from 680° C. to 850° C. for the parallel specimen, and that from 815° C. to 840° C. for the perpendicular one. Thus, the dissociation temperature is clearly defined from the side of the electrical conductivity. AUTHOR.

See also Abstracts 4752, 4958, 5002, 5012, 5036, 5064.

DIELECTRICS AND CAPACITANCE.

5031. Dipole Moment and Solvent. H. Müller. *Phys. Zeits.* 34. *pp.* 689–710, *Sept.* 15, 1933.—An apparatus for measurement of the dielectric constants of liquids is described, which, owing to the high degree of accuracy attained, enables the dependence of the molecular polarisation of dissolved substances upon the solvent to be established. Consideration of the experimental errors likely to occur, shows that the variations in the polarisation values lie outside the limits of error. Various influences of the solvent upon the dissolved substance have been distinguished, but the essential effect appears to be solely a function of the dielectric constant of the solvent. For many substances an empirical equation has been established, which enables the dipole moments of the free molecules of substances which cannot be treated in gaseous form to be extrapolated from experiments on solutions. Theoretical considerations appear to involve the assumption of a saturation effect in the electric fields of the dipoles, on analogy with the theory of the dielectric constant of dilute solutions of electrolytes. Such an explanation leads to an estimation of the electric field strength, which causes the alteration of the optical polarisability of a molecule to be necessary. H. H. Ho.

5032. Dielectric Polarisation. Parts VIII-XI. E. G. Cowley and J. R. Partington. *Chem. Soc. J. pp.* 1252–1259, *Sept.*, 1933.—Part VIII deals with the dipole moments of alkyl nitrates and nitrites and continues Part VII on nitro-compounds [see Abstract 2566 (1933)]; the data are for nitrates: methyl (2·85), ethyl (2·91), *n*-propyl (2·98), *n*-butyl (2·96), and for nitrites: ethyl (2·20) and *n*-propyl (2·28) $\times 10^{-18}$ e.s.u. Part IX records the dipole moments for some nitrosoamines: dimethyl (3·98), diphenyl (3·39), monomethyl (3·62) and monoethyl (3·61), and for *p*-nitrosophenol (4·72), hydrazobenzene (1·66) and benzaldehyde phenylhydrazone (1·89). These results are discussed. Part X gives the moments for the 3 nitro-anisoles viz.: *o*-(4·83), *m*-(3·86), *p*-(4·74), which are compared with those for the 3 nitrophenols, viz., *o*-(3·10), *m*-(3·90), *p*-(5·05). The order in the two series is not the same, and the irregularity seems to be exhibited by the *o*-compounds, since the other isomerides show regularity. Part XI is a note on the dipole moment of pyrrole (1·83) which was determined to investigate the effect of the size of the ring on the moment. H. H. Ho.

5033. Electric Moments in Solution by the Temperature Coefficient Method. Part I. Experimental Method and Electric Moments of Benzyl Compounds. F. Fairbrother. *Roy. Soc., Proc.* **142.** *pp.* **173–197,** *Oct.* **2, 1933.**—The electric moments of several compounds have been estimated from measurements in solution over temperature ranges of 100° and 140° and from measurements of refractive indices, and polarisability in the solid state, thereby obtaining some information of the magnitude of atomic polarisation and the effect of temperature on the electric moment. Dielectric constants were measured at approximately 1,000 kc. (300 m.) by a resonance method having a piezoelectrically controlled oscillator. The solvents used were decahydronaphthalene and *p*-xylene. The decahydronaphthalene was prepared from a mixture of the *cis* and *trans* isomers obtained by fractional distillation of technical " Dekalin." Both isomers, the solvent mixture, and *p*-xylene are shown to be non-polar ; in each substance the polarisation increases slightly with rise of temperature. The estimated electric moments of benzyl alcohol and benzyl chloride are respectively $1 \cdot 6$ and $1 \cdot 72 \times 10^{-18}$ e.s.u. Extrapolation of polarisation to infinite dilution can be carried out with greater accuracy at high temperatures. From measurements of the polarisations of *o*-, *m*-, and *p*-nitrobenzyl chlorides throughout the temperature range 20° to 120° the moments have been calculated as, *o*-3·93-3·97, *m*-3·71-3·80, *p*-$3 \cdot 45 \times 10^{-18}$ e.s.u., the *p*- being the only one unaffected by temperature. These results are consistent with the view that the rotation of the—CH_2Cl group about its axis is unhindered in the *p*-, and most hindered in the *o*-derivative. W. R. A.

5034. Influence of a Magnetic Field on the Dielectric Constants of Argon and Oxygen. H. Voss. *Zeits. f. Physik,* **85. 3–4.** *pp.* **172–179,** *Sept.* **4, 1933.**—A resonance method is described in which the gradient of the resonance curve is applied to the measurement of small alterations in dielectric constant. A variation of 10^{-8} can be detected. By this method it is shown that a magnetic field of 1080 gauss has no influence on the dielectric constant of argon and oxygen for wave-lengths of 30 m., the variations being less than $4 \cdot 6 \times 10^{-7}$ for argon and $3 \cdot 1 \times 10^{-7}$ for oxygen. W. R. A.

5035. H.F. Properties of Dielectrics. K. Nakamura. *Tohoku Univ., Sci. Reports,* **22.** *pp.* **614–631,** *Aug.,* **1933.** *In English.*—Measurements, by the method of resonance, of the variations of capacity and h.f. resistance of natural quartz. The theoretical investigation indicates that the voltage resonance is affected by the effective leakage conductance of the condenser to no small extent. Method given for correcting this effect on the measured value of capacity. With quartz plate cut parallel to the optical axis, the capacity varies linearly with temperature, the rate of increase being rather small. Its h.f. resistance also increases with temperature in some degree. At the $\alpha \rightleftarrows \beta$ transformation point, 573° C., it indicates a small discontinuity. With quartz plate cut perpendicular to the optical axis, the capacity and resistance vary extraordinarily with temperature : the value of capacity at 573° C. is almost eight times that at room-temperature, and the resistance first decreases up to 490° C. and then increases again : the minimum value of resistance is only five ten-thousandths of that at 55° C. The frequency employed was 1800 per sec. A. D.

5036. Effect of Temperature and Frequency on the Dielectric Constant, Power Factor, and Conductivity of Compounds of Purified Rubber and Sulphur. A. H. Scott, A. T. McPherson and H. L. Curtis. *Bureau of Standards, J. of Research,* 11. *pp.* 173–209, *Aug.,* 1933.—The data were determined at temperatures from —75° to 235° C. The dielectric constant and power factor were measured at 5 frequencies from 60 to 300,000∼ and the apparent conductivity at about 0·002 second and at 1 min. after the applications of potential. The results are expressed in both tabular and graphic form. At 25° C. and 1000∼ the dielectric constant of purified rubber containing no sulphur was 2·37, and increased with increasing sulphur content to 3·75 for 11·5%S ; then decreased to a minimum of 2·70 for 22% S and again increased to 2·82 at 32% S. The power factor increased from 1·6 × 10^{-3} for rubber alone to 93·8 × 10^{-3} at 13·5% S, decreased to about 4·0 × 10^{-3} for 20% S and again slowly increased to 5·1 × 10^{-3} for 32% S. The 1-minute conductivity was 2·3 × 10^{-17} mhs./cm. for rubber alone, 0·5 × 10^{-17} for 12% S content, 38 × 10^{-17} for 18% S and 1 to 1·5 × 10^{-17} for 22–32% S. Changes of temperature or frequency shifted the maxima and minima and modified the heights of the curves. Comparison of the results on purified rubber with previous work on crude rubber indicates that purification alters the values obtained for the electrical properties, but does not modify the general manner in which these properties vary with changes in composition, temperature, or frequency. The results should have a practical bearing on the selection of rubber compounds for specific uses. H. H. Ho.

5037. Corrections for Plane Condensers. F. Keller and W. R. Lehmann. *Zeits. f. Physik,* 85. 3–4. *pp.* 253–257, *Sept.* 4, 1933.—The departures (due to the scattering of the peripheral lines of force) of the observed capacity-value from the calculated value $C = \epsilon F/4\pi d$ measured for plate-areas 1·77 to 100 cm². and distances *d* from 1 to 6 mm. A. D.

5038. Capacity Meter. W. L. Beck. *Phys. Soc., Proc.* 45. *pp.* 765–767, *Nov.* 1, 1933.—A new form of capacity meter is described which simplifies the comparison of capacities over a wide range of values. AUTHOR.

ELECTROCHEMISTRY.

5039. Extent of Dissociation of Zinc Sulphate. C. W. Davies. *Faraday Soc., Trans.* 29. *pp.* 834–835, *Aug.,* 1933.—The paper is a criticism of Cowperthwaite's use of the author's data to calculate activity values [see Abstract 3789 (1933)]. F. J. B.

5040. Activity Coefficients of Hydroxyl Ion in Solutions of Calcium Hydroxide at 30° C. E. P. Flint and L. S. Wells. *Bureau of Standards, J. of Research,* 11. *pp.* 163–171, *Aug.,* 1933.—Measurements of the e.m.f. of the cell, $H_2/Ca(OH)_2$ (c) | KCl (saturated) | HgCl + Hg, at 30°, when potentials due to the liquid junction and saturated calomel half cell were eliminated, yielded values of the e.m.f. of the half cell, H_2 | $Ca(OH)_2$ (c). From these values the pH and activity coefficients of hydroxyl ion in solutions of calcium hydroxide as a function of concentration have been obtained for solutions containing between 0·050 and 1·199 gm. CaO per litre. A value of K_w, the dissociation constant of water, at 30° was derived from the data. AUTHORS.

5041. Isotopic Fractionation of Water. E. W. Washburn, E. R. Smith, and M. Frandsen. *Bureau of Standards, J. of Research,* 11. *pp.* 453–462, *Oct.*, 1933.—When water is subjected to electrolysis an isotopic fractionation takes place, the evolved hydrogen being richer in the H^1 isotope and the evolved oxygen richer in the O^{16} isotope than is the water from which they are evolved. If the gases resulting from the electrolysis of water are recombined, the water produced has a lower density than the water from which they were evolved. The residual water grows progressively more dense as the electrolysis proceeds, owing to the increasing concentration of the H^2 isotope of hydrogen and, to a less extent, also of the O^{18} isotope of oxygen. Curves illustrating the efficiency of the fractionation process are given. Substantially pure H^2, pure H^1, and pure O^{16} can be obtained by this fractionation process. The heavy water obtained by the process has a higher freezing point, a higher boiling point, and a lower refractive index than normal water. Isotopic fractionation of water by distillation and by adsorption has also been accomplished. A differential pycnometer method for measuring specific gravity, accurate to 1 part in a million, is described. AUTHORS.

5042. Theory of Overvoltage. O. Essin. *Zeits. f. phys. Chem.* 166. *Abt. A.* 3–4. *pp.* 270–272, *Sept.*, 1933.—It is shown that, without requiring any special assumption, but merely by allowing for the velocity of the opposite reaction, Erdey-Grúz and Volmer's theory [see Abstract 1059 (1931)] furnishes an explanation of the peculiar effect of the H-ion concentration on overvoltage. T. H. P.

5043. Electroendosmosis and Electrolytic Water-Transport. Part III. Solutions of Copper Salts. H. C. Hepburn. *Phys. Soc., Proc.* 45. *pp.* 755–764, *Nov.* 1, 1933.—This paper gives the results of measurements of the liquid-transport produced by passing an electric current through aqueous solutions of cupric chloride and of cupric nitrate, the solution in each case being symmetrically divided by means of a parchment-paper diaphragm perpendicular to the direction of the flow of electricity. The results are considered in relation to data obtained previously by the author in the case of solutions of copper sulphate; and the electroendosmotic effect of the parchment-paper diaphragm is discussed in terms of the influence of the electrical charge of the diaphragm and of the thickness of the electrical double layer formed at the interface diaphragm-aqueous solution. The results obtained with the solutions of cupric chloride show that the direction of liquid transport is reversed in the case of the more concentrated solutions, and evidence is adduced suggesting that this reversal is attributable to the effect of the electrolytic water-transport. [See also Abstract 3994 (1932).] AUTHOR.

5044. Single Potential of Aluminium. H. Endô and S. Kanazawa. *Tohoku Univ., Sci. Reports,* 22. *pp.* 537–552, *Aug.*, 1933. *In English.* *Report No.* 305 *of the Research Inst. for Iron, Steel and other Metals.*—The single electrode potential of Al in NKCl solution has been measured very carefully with the following results: (1) When various gases are passed over the electrolytic solution contained in the electrode vessel, the results are not always identical, *i.e.*, in the cases of H_2, N_2 and CO_2, the results being quite similar, no effects are observable, while in the case of O_2, a remarkable lowering of the potential (absolute value) takes place; the effect of the last gas may be satisfactorily explained as the result of the formation of oxide film on the electrode surface. (2) Various samples of Al give different results due to the difference in the quantity of impurities contained. (3) Fe added to Al steadily lowers the electrode potential, but Si does not do so. Therefore, from the relation, voltage-iron content, the value − 1·29 volts has been evaluated as the most probable value for the single electrode potential of pure Al. AUTHORS.

5045. Silver-Silver Iodate Electrode. J. N. Pearce and V. I. Wirth. *Am. Chem. Soc., J.* 55. *pp.* 3569–3571, *Sept.*, 1933.—The e.m.f.s of a series of cells of the type Hg, Hg_2Cl_2, KCl, KIO_3, $AgIO_3$, Ag, were measured at 25°. By combining the results with the potentials of the corresponding calomel electrodes, the potential of the Ag, $AgIO_3$, IO^- electrode is found to be 0·3569 volt. N. M. B.

5046. Polarisation Currents Due Solely to Changes in Electrode Area. K. E. Glidden and W. A. Patrick. *Am. Chem. Soc., J.* 55. *pp.* 3594–3602, *Sept.*, 1933.—The current flowing between a fixed and expanding mercury surface, both surfaces in contact with a solution of mercurous sulphate, was measured. The absorption of mercurous ions is found to be constant above a certain critical concentration, if it is assumed that the current measured was equivalent to the adsorption of mercurous ions. The lowering of the interfacial surface tension between mercurous sulphate solution and mercury is accounted for by the formation of an oriented unimolecular layer of mercurous sulphate particles at the mercury surface. F. J. B.

5047. Formation of Tantalum in Non-Aqueous Solvents. P. O. Schupp. *Zeits. f. Elektrochem.* 39. *pp.* 731–735, *Sept.*, 1933.—The solvents investigated [see Abstract 365 (1933)] were formamide, acetone, methylethyl ketone, pyridine, acetic acid, and sulphuric acid. The results indicate that great care must be taken both in measuring the capacity and in comparing the capacities in the different solvents. In all cases the thickness of the layer for the same formation voltage was the same as with aqueous solutions and is hence independent of the solvent. T. H. P.

5048. Anodic Behaviour of Nickel. Part III. K. Georgi. *Zeits. f. Elektrochem.* 39. *pp.* 736–743, *Sept.*, 1933.—Principally a discussion of the theoretical significance of the results previously recorded [see Abstract 375 (1933)], with additional data relating to the influence of hydrogen peroxide, ferric chloride, and chromic acid on the rate of dissolution of nickel in hydrochloric and sulphuric acids. It is shown that whereas by anodic polarisation of nickel in an acid a large number of points on the surface of the metal may be rendered active, chemical oxidising agents do not produce the same effect so readily, and when the most accessible of the potentially active points have become covered with a film of nickelic hydroxide the metal remains practically inert. In the case of hydrogen peroxide a certain degree of activity results from the occurrence of the reaction $2Ni^{\cdot\cdot\cdot} + H_2O_2 \rightarrow 2Ni^{\cdot\cdot} + 2H^{\cdot} + O_2$. Transition from the active state to the stable " B " state (at 1·5 volt) results from removal of hydrogen ions from the diffusion layer, whilst at higher potentials the formation of oxide layers probably plays a part. H. F. G.

5049. Anodic Behaviour of Iron. K. Georgi. *Zeits. f. Elektrochem.* 39. *pp.* 745–749, *Sept.*, 1933.—Although the results of measurements of the potential of iron in normal acid and salt solutions are not readily reproducible, they resemble on the whole those obtained with cobalt, the values being about 0·2 volt higher. Anodic polarisation of iron in acid solutions, up to 0·12 ampere per cm^2., causes but little change of the limiting potential in presence of air. Formation of ferrous ions, however, is accompanied by large potential changes, except in the case of halide solutions; separation of oxygen occurs, with a sudden rise of potential, at about 1·7 volt, except in the case of perchlorate solutions, in which the maximum potential is 1·4 volt. Increase of the pH to 3·0 greatly favours the process of dissolution. Measurements have been made of the current yield at a number of constant values of current density. Perchlorate solutions are exceptional in that the yield is relatively low (92·5 %) and the iron rapidly becomes covered with ferric hydroxide; in contradistinction to the case of nickel, oxygen is not evolved. The results are discussed in their relation to the question of passivity. H. F. G.

5050. Interchange between the Atoms and Ions of a Metal. O. Erbacher. *Zeits. f. phys. Chem.* 166. *Abt.A.* 1–2. *pp.* 23–26, *Sept.*, 1933.—When certain metals are in contact with solutions of their ions, local elements are set up as a result of the varying solubilities at different points on the surface of the metal; under these conditions interchange of atoms and ions takes place to a depth in the surface corresponding with many layers of atoms. If the metal (*e.g.*, lead or bismuth) is previously etched with nitric acid, however, the extent of the interchange which occurs is only three to four times as great as that which would correspond with the deposition of a single layer of atoms on a polished surface of the same overall dimensions, and since the true area of an etched surface is several times as great as that of a polished surface of the same extent, it is probable that with the etched metal local element formation does not occur, and that the observed interchange is a purely kinetic effect involving only the surface layer of atoms. H. F. G.

See also Abstracts 4918, 5017.

ELECTRONS AND PROTONS.

5051. Anomalous Reflection of Fast Electrons at the Surface of a Single Crystal. S. Kikuchi and S. Nakagawa. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 443. *pp.* 256–265, *Sept.*, 1933. *In German.*—Continuing previous work [see Abstract 3799 (1933)], the anomalous reflection of fast electrons of energies about 100 kV. at the surface of a single ZnS crystal is examined. Photographs of normal and anomalous spectra are reproduced: the dependence of the spectra upon the azimuth is very marked. The anomalies are of two types, (1) splitting of the normal maxima into two or more maxima, (2) appearance of new maxima. The results are closely related to those of Davisson and Germer using slow electrons; these are explained on the grounds of anomalous dispersion. Finally, the breadth of the maxima were measured and found to be very much larger than was to be expected on Bethe's theory. F. C. C.

5052. Mott Polarisation Effect in the Scattering of Electrons by Atoms. F. Sauter. *Ann. d. Physik,* 18. 1. *pp.* 61–80, *Sept.*, 1933.—The Born-Dirac collision method is used to calculate the distribution of electrons produced by twice scattering an electron beam. The method is applicable to scattering by crystal lattices, potential barriers, and similar processes involving a non-Coulombian scattering field, whereas the method used by Mott [see Abstract 2983 (1932)] is only applicable to Coulomb fields. Results obtained by the two methods agree in the special case of a Coulomb field. It appears that the electron shells of the scattering atom do not seriously alter the polarisation effect in scattering at 90° of electrons whose energy is greater than the binding energy of the atomic electrons. J. E. R. C.

5053. Inelastic Scattering of Slow Electrons in Gases. Part III. F. H. Nicoll and C. B. O. Mohr. *Roy. Soc., Proc.* 142. *pp.* 320–332, *Oct.* 2, 1933.—An apparatus has been constructed, similar to that described in a previous paper [see Abstract 756 (1933)] but specially designed for work with electrons whose energies lie within a few volts of the excitation potential. Results have been obtained for the inelastic scattering of electrons in hydrogen, helium, and argon, the results covering an angular range of 10° to 155° and a range of seven voltages between about 80 volts and about 3 volts above the excitation potential. The curves for the inelastic scattering in argon show diffraction effects at large angles which are similar to those which appear in the elastic scattering, but which disappear as the energy of the electrons approaches the excitation potential of the gas. The curves for hydrogen and helium do not exhibit any unusual features for low velocity electrons, and the significance of the curves is discussed. Unlike the elastic scattering, the inelastic scattering at small angles (between 10° and 30°) is seen to agree in form fairly well with that given by the Born formula down to relatively low velocities. AUTHORS.

5054. Diffraction of Fast Electrons by Single Crystal of Brucite. G. Aminoff. *Arkiv. f. Kem. Min. och Geologi*, 11*B*. 10. [4 *pp*.], 1933. *In German.*—An electron diffraction photograph obtained from a single crystal of brucite gives a value of $3 \cdot 11_5$Å for the length of the *a*-edge of the hexagonal unit cell. This is in good agreement with that obtained by X-ray analysis. The effective wave-length is obtained by taking a comparison photograph of muscovite. It is found to be 0·051 Å. J. T.

5055. Diffraction of Slow Electrons by a Single Tungsten Crystal. R. v. Meibom and E. Rupp. *Ann. d. Physik*, 18. 1. *pp.* 107–120, *Sept.*, 1933.—Measurements were made of the diffraction of slow electrons with energies ranging from 25 to 600 volts, at the surface of a single tungsten crystal. Electron tubes of fixed angle and tubes with rotating electron gun and fixed collector are described. Out of 127 maxima recorded, 87 were explained as whole-order maxima. From the average of 38 of these, an internal potential of $E_0 = 10 \cdot 9 \pm 1 \cdot 6$ volts was obtained. At the same time 49 maxima gave an average potential of $E_0 = -0 \cdot 1 \pm 1 \cdot 9$ volts. No connection appears to exist between the internal and the applied potential; the negative sign cannot therefore be interpreted as anomalous dispersion. Real half-order interference appears to account for 29 maxima, 19 of which gave an average value of $E_0 = 0 \cdot 9 \pm 1 \cdot 6$ volts and 10 an average of $E_0 = 11 \cdot 0 \pm 1 \cdot 6$ volts. 11 maxima remain unexplained. F. C. C.

5056. Electron Diffraction Patterns from Platinised Asbestos. D. A. Richards. *Phil. Mag.* 16. *pp.* 778–787, *Oct.*, 1933.—Electron diffraction patterns have been obtained from platinised asbestos, the platinisation being effected by reduction of platinic chloride in hydrogen. Increasing quantities of Pt were added and the transition from the asbestos diffraction pattern to that corresponding to Pt observed. A quantitative estimation of the ratio of Pt to asbestos in the final state of the specimen was made, and also an approximate determination of the upper and lower limits of the thickness of the Pt deposit, and thence an estimation of the area of asbestos covered by the deposit. The large surface of asbestos required was consistent with the diffuse rings obtained in the diffraction pattern after the Pt had been dissolved in aqua regia. Possible explanations why the Pt structure does not appear until a high degree of platinisation has been effected are considered, and the observed phenomena appear to indicate that the platinisation results in a splitting of the fibres, with the result that a fresh surface of asbestos is presented to the electron beam, nullifying the effect of the additional Pt. AUTHOR.

5057. Shape of an Electron Beam in a Magnetic Field. N. F. Barber. *Leeds Philosoph. and Lit. Soc., Proc.* 2. *pp.* 427–434, *July,* 1933.—The elliptical cross-section of a beam of electrons diffracted by passage through a thin crystalline film and the angle of deviation of the beam necessary for maximum sensitivity are deduced. The sensitivity of different arrangements having the same total path is discussed theoretically and the distortion of the elliptical zone is calculated for a particular case. [See also Abstract 3206 (1933).] H. J. H. S.

5058. Inner Potential of Metals. J. A. Darbyshire. *Phil. Mag.* 16. *pp.* 761–775, *Oct.,* 1933.—Definite evidence of refraction due to an inner potential has been found when high speed electrons are reflected from cleavage faces of Zn and Sb, but not from Bi and Te. The experiment demands a very exacting perfection of the cleavage faces, which is difficult to attain in the case of metal single crystals. The values of the inner potential deduced from the present work are Sb $E_0 = 12$ volts and Zn $E_0 = 15\cdot5$ volts. These are believed to be accurate to within at least ± 1 volt in each case. AUTHOR.

See also Abstracts 5006, 5007.

ELECTROSTATICS.

5059. Contact P.D. Between Different Faces of Copper Single Crystals. B. A. Rose. *Phys. Rev.* 44. *pp.* 585–588, *Oct.* 1, 1933.—Measurements on the contact p.d. between the (111) and (100) faces of copper single crystals, at different stages of outgassing, were made by the Kelvin null method. Two sets of observations with different experimental tubes show that the (111) face assumes a positive potential with respect to the (100) face. This value increased rapidly from near zero to about 0·4 volt during the first few hours of outgassing at a dull red heat and then more slowly to a limiting value of $0\cdot446 \pm 0\cdot002$ volt at 20 hours in the first series and $0\cdot463 \pm 0\cdot002$ volt at 70 hours in the second series of measurements. Further heating at temperatures which exposed other faces by evaporation caused the value, in the first series, to decrease to 0·384 volt after 100 hours of outgassing, and in the second series, after 275 hours, it decreased to 0·378 volt. This value, 0·378 volt, remained constant for the next 770 hours of outgassing. This difference between the results of the two series of measurements is due to different rates of outgassing. Observations were taken at pressures of about 5×10^{-8} mm. Hg as measured on an ionisation gauge. The outgassing was more than that required to reduce the surface gas layer to such thickness that it possesses a definite crystal structure related to that of the underlying copper, as shown by Farnsworth. Thus the above results should be characteristic of the single crystals contaminated with undesired crystal facets and probably covered with small traces of gas of crystalline structure, both of which reduce the effective value. These results definitely indicate that the contact p.d. between the (111) and the (100) faces of uncontaminated copper single crystals must be greater than the final value obtained here and most probably greater than the maximum value of 0·463 volt. AUTHOR.

5060. Capacity of Dolezalek Electrometers. G. Nadjakoff. *Phys. Zeits.* 34. *pp.* 682–687, *Sept.* 1, 1933.—Using a method described previously [see Abstract 3445 (1932)] measurements have been made of the fundamental constants of a Dolezalek electrometer as modified by Bartel. The effect of varying the needle potential and the suspension is investigated and the limiting value of the former is discussed. A practical limit to the effective capacity is also discussed. The manner in which the capacity is affected by working with different charge and voltage sensitivity is investigated using both the idiostatic and heterostatic arrangements. The fact that high needle potentials deform the needle and thus introduce additional complications is noted and the effect of this upon the fundamental constants is discussed. J. E. R. C.

5061. Extension of Limits of Application of the Duant Vacuum Electrometer. K. Diebner. *Zeits. f. Physik,* 85. 5–6. *pp.* 373–383, *Sept.* 14, 1933.—By reducing the moment of inertia of the needle and increasing the restoring force acting on it, its time of action is reduced and discontinuities in the curve of deflection are sharper, so that 150 or more corpuscular rays can be recorded per hour. By increasing the sensitivity of the instrument ten times, it is possible to distinguish between H- and α-particles due to shattering and the slower secondary variations in ionisation due to the disturbing radiations. H. M. B.

5062. Effective Capacity of the Lindemann Electrometer. J. J. McHenry. *Journ. Sci. Instruments,* 10. *pp.* 305–310, *Oct.,* 1933.—A theoretical expression for the effective capacity of the Lindemann electrometer is deduced and found correct when tested by experiment. The effective capacity of the electrometer used is found to change, under good working conditions, from about 6·2 cm. to 10·2 cm. as the p.d. between the plates is altered from 20 to 48 volts. At 48·75 volts, just before the needle becomes unstable, the capacity reaches a value of 17 cm. AUTHOR.

5063. Braun Electrometer with Strip Suspension. A. Wehnelt and J. Johannesson. *Zeits. f. techn. Physik,* 14. 9. *pp.* 349–350, 1933.—A brief description is given of an electrometer with a moving system suspended by a thin metallic strip. Magnetic damping is provided and is such that the system is practically aperiodic. The horizontal scale can be read to about 1/10 of a degree, corresponding to an accuracy of 2 to 4 volts, since the full scale deflection of the instrument, as made by Leppin and Masche, is 1000 volts. The electrometer capacity is almost independent of the applied potential and has a value of 8–9 cm., which is considerably smaller than that of the usual type of multicellular instruments of corresponding range. The ohmic resistance of the suspension is about 6 ohms, which gives the cosine of the loss angle to be about 4×10^{-4} for a.c. of frequency 10^6 p.p.s. A. W.

5064. Electrostatic Generating Voltmeter. G. P. Harnwell and S. N. van Voorhis. *Rev. Sci. Instruments*, 4. *pp*. 540–541, *Oct.*, 1933. —An electrostatic generating voltmeter is described which has a strictly linear scale, which has no commutators, and whose calibration is substantially independent of the speed of the driving motor and of the characteristics of the associated valve amplifier. A means of calibration by use of a wire grid in front of the voltmeter is also described. AUTHORS.

See also Abstracts 4837, 4888, 5058. 5030

GALVANOMAGNETIC AND THERMOMAGNETIC EFFECTS.

5065. Change of Resistance of Metals in a Magnetic Field at Low Temperatures. W. J. de Haas and P. M. van Alphen. *K. Akad. Amsterdam, Proc.* 36. 3. *pp*. 253–262, 1933. *Comm. No.* 225*a from the K. Onnes Lab., Leiden.*—Previous work describes the results of investigations on the change of resistance of single crystals of pure bismuth and on the simultaneous occurrence of a dependence of their diamagnetic susceptibility upon the magnetic field. The present work records a series of measurements not only of the magnetic properties, but also of the change in resistance of a series of alloys and metals in the region of hydrogen temperatures as also at higher values. Details of experimental technique are given. It is established that a high diamagnetism and a marked change of resistance go together. Impurities have a greater influence upon the resistance change at low temperatures than at high ones. Alteration of the angle between the directions of the current and of the field, *i.e.*, from the transverse to the longitudinal, changes the resistance in the same way as the alteration of the angle between the principal and secondary axes does for a mono-axial crystal. For other crystals the phenomena are very complex. S. G. B.

5066. Crystal Structure and Electrical Properties. Part II. Lattice Structure and Conductivity of Single Crystals of Bismuth in a Transverse Magnetic Field. O. Stierstadt. *Zeits. f. Physik*, 85. 5–6. *pp*. 310–331, *Sept*. 14, 1933.—Continuing the work described previously [see Abstract 2054 (1933)], the author modified his experimental method to enable the direction of the magnetic field and the direction along which the electrical conductivity of the Bi crystal was being measured to be kept at a fixed angle (90°), while the crystal itself was rotated about an axis parallel to the electric current. Thus it was only the direction of the magnetic field with respect to the crystal axes which was varied. The diagrams obtained of the percentage change of electrical conductivity due to the magnetic field, for different orientations of the bismuth crystal were found to exhibit the symmetry properties of the crystal lattice and to lead in fact to a unique determination of the lattice structure save for the size of the elementary cell. W. S. S.

MAGNETISM AND ELECTROMAGNETISM.

5067. Electromagnetic Analogy. E. Frola. *Accad. Sci. Torino, Atti.* 68. 4–10. *pp*. 525–528, 1933.—Establishes an analogy between shearing forces in beams and the forces in electromagnetic fields. Deduces a method for determining the tangential forces and the reactions of the supports in beams simply supported at their periphery. A. D.

V.
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5068. Heaviside's Calculus. K. T. Vahlen. *Zeits. f. angew. Math. u. Mechanik*, 13. *pp.* 283–298, *Aug.*, 1933.—Mathematicians have pointed out the limitations of the scope of Heaviside's calculus. The author here, developing from first principles, amends and generalises Heaviside's working. A. D.

5069. Magnetic Dipole Fields in Unsaturated Cubic Crystals. L. W. McKeehan. *Phys. Rev.* 44. *pp.* 582–584, *Oct.* 1, 1933.—The mean value of the randomly directed local magnetic field at a lattice point in each of two cubic arrays, (I) and (F), of equal magnetic dipoles is computed under the following restrictions : (*a*) The orientation of neighbouring dipoles is independent. (*b*) The direction of each dipole axis is one of the easy directions of magnetisation for a ferromagnetic metal having the array in question. (*c*) The mean magnetisation in any group of about 2000 dipoles is an assigned fraction of the saturation values ; *viz.*, 0, 0·1, ·03, ·05, 0·7 or 0·9. The results indicate that for materials wherein local constraints prevent the parallel alignment of adjacent magnetic elements an important cause of high coercive force may be the high intensity of local magnetic fields. [See Abstract 3810 (1933).] AUTHOR

5070. Paramagnetic Saturation of Potassium Chromic Alum. C. J. Gorter, W. J. de Haas and J. van den Handel. *K. Akad. Amsterdam, Proc.* 36. 2. *pp.* 158–167, 1933. *Comm. No. 222a from the K. Onnes Lab., Leiden.*—The paramagnetic saturation of potassium chromic alum has been studied, with the aid of a new apparatus down to T = 1·34° and field-strengths of 21 oersteds. The results agree with the theory of Bose-Stoner. No influence of orbital magnetism could be detected.

AUTHORS.

5071. Magnetic Behaviour of Chromic Compounds at Low Temperatures. C. J. Gorter, W. J. de Haas and J. van den Handel. *K. Akad. Amsterdam, Proc.* 36. 2. *pp.* 168–173, 1933. *Comm. No. 222e from the K. Onnes Lab., Leiden.*—The susceptibilities of some basic chromic sulphates, of Cr_2O_3 and of $[CrCl_2 . (H_2O)_4] . Cl . 2H_2O$ have been determined between 14° and 290°. Only the susceptibility of the chloride-hexahydrate follows approximately the theoretical law for chromic compounds. The possible reasons for the deviations are discussed.

AUTHORS.

5072. Magnetic Properties of Metals at Low Temperatures. W. J. de Haas and P. M. van Alphen. *K. Akad. Amsterdam, Proc.* 36. 3. *pp.* 263–270, 1933. *Comm. No. 225b from the K. Onnes Lab., Leiden.*—The specific susceptibility of 17 elements and 2 alloys has been measured at room-temperature (289° K.) and again in the region 20 to 40° K., using apparatus previously described [see Abstract 1667 (1931)]. The paramagnetic susceptibility of Mg and Mo increased rather rapidly with temperature, especially at low temperatures, whilst a small increase was observed for W, Nb and white Sn. The diamagnetic susceptibility of graphite, Cu, Zn, grey Sn, Sb, Te, I, Pb, Bi and Tl was practically constant at low temperatures but Cd showed a marked increase as the temperature was lowered. On raising the temperature from about 20° K. to 289° K. the susceptibility of these elements slowly decreased whilst that of Si, Se, Cs and Au remained constant. The influence of impurities in the samples was shown by the course of the susceptibility curve at low temperatures.

H. J. H. S.

5073. Magnetic Properties of Iodine in Different Solvents. S. S. Bhatnagar and C. L. Lakra. *Indian Journ. Phys.* 8. *pp.* 43–47, *July* 15, 1933.—The susceptibility of iodine in solutions was measured by a modified Bauer and Piccard method. Iodine has a specific susceptibility $-0\cdot51 \times 10^{-6}$ when dissolved in benzene or in carbon disulphide, and a value $-0\cdot35 \times 10^{-6}$ when dissolved in cyclohexane. The second value coincides with that for solid iodine, and it is concluded that the iodine tends to ionise in the first two solvents but not in the third. G. E. A.

5074. Susceptibilities of Paramagnetic Solutions. E. Vogt. *Phys. Zeits.* 34. *pp.* 687–688, *Sept.* 1, 1933.—Fahlenbrach's and Gorter's [see Abstract 3830 (1933)] interpretations of the results for solutions of the salts of the iron series are discussed. W. R. A.

5075. Magnetic Deviation of Hydrogen Molecules and the Magnetic Moment of the Proton. Part I. R. Frisch and O. Stern. *Zeits. f. Physik*, 85. 1–2. *pp.* 4–16, *Aug.* 29, 1933.—Experimental details are given of the method for the determination of the magnetic moment of hydrogen positive rays by magnetic deviation. Measurements with para-hydrogen give a magnetic moment of 1 nuclear magneton ; ortho-hydrogen a value of 2 to 3. [See following Abstract.] W. R. A.

5076. Magnetic Deviation of Hydrogen Molecules and the Magnetic Moment of the Proton. Part II. I. Estermann and O. Stern. *Zeits. f. Physik*, 85. 1–2. *pp.* 17–24, *Aug.* 29, 1933.—Accurate investigation of the deviation of hydrogen molecular rays gives the value of $2\cdot5$ nuclear magnetons ($\pm$ 10%) for the magnetic moment of the proton, and the value $0\cdot8 - 0\cdot9$ for the rotation moment of the hydrogen molecule. Deviation curves for ortho and para hydrogen are given. [See preceding Abstract.] W. R. A.

5077. Magnetic Moment of a Rotating Hydrogen Molecule. G. C. Wick. *Zeits. f. Physik*, 85. 1–2. *pp.* 25–28, *Aug.* 29, 1933.—Theoretical. The " magnetic rotation moment " of hydrogen is calculated and compared with the experimental value. The result is tabulated together with values for the energy of dissociation and the magnetic susceptibility per mol. W. R. A.

5078. Magnetic Deviation of Oxygen Molecules. R. Schnurmann. *Zeits. f. Physik*, 85. 3–4. *pp.* 212–230, *Sept.* 4, 1933.—The magnetic deflection of O_2 molecules in an asymmetrical field was investigated. The results agree with the hypothesis that the oxygen molecule has a magnetic moment of two Bohr electrons, and that there exists a coupling action between the moment of momentum of the electrons and the angular momentum of the molecule. G. E. A.

5079. Magnetic Study of Single Electron Bindings in Compounds of the Type of Tellurium Dimethyl Dihalide. S. S. Bhatnagar and T. K. Lahiri. *Zeits. f. Physik*, 84. 9–10. *pp.* 671–675, *Aug.* 12, 1933.—Tellurium dimethyl chloride, bromide, iodide and nitrate have been measured at various temperatures and the susceptibilities are independent of temperature. From this and a comparison of observed and computed values for the susceptibilities it is concluded that the occurrence of a single electron link in these compounds is improbable. W. R. A.

5080. Motion of Lines of Induction. G. Darrieus. *J. de Physique et le Radium*, 4. *pp*. 388–405, *July*, 1933.—The author gives a résumé of Milner's investigations [see Abstract 560 (1929)] in which a modification of the idea of tubes of induction is developed, the tubes being replaced by four dimensional elements each containing an amount of action equal to Planck's quantum *h*. These elements give a concrete expression to Heisenberg's principle of indeterminacy and suggest connections with Eddington's theory of electric charge and other recent work. W. S. S.

5081. H.F. Magnetic Field of a Flat Spiral Coil. S. Githens, Jr., and O. Stuhlman, Jr. *Rev. Sci. Instruments*, 4. *pp*. 542–545, *Oct*., 1933.—The h.f. magnetic field of a flat spiral coil, with an inner opening about one-fourth the diameter of the coil, was excited by single-tube tuned plate-tuned grid and push-pull oscillators. Frequency range 1500 to 6000 kc/sec. The magnetic fields thus excited were compared with the fields produced by a direct current. The results when a push-pull oscillator was used to excite the h.f. field showed no apparent difference except near the far edges lying about 25 cm. from the centre of the coil, and were independent of frequency. Unbalanced h.f. excitation showed magnetic field crowded toward the normal axis when filament lead was connected to inner turn of spiral. Field strength across inner diameter was found to be non-uniform when field was excited by a balanced push-pull oscillator. Field strength along normal axis of coil diminished more rapidly for a balanced than for unbalanced excitation, independent of method of lead connections and was much smaller for the case of filament lead connected to outer end of spiral. [See also Abstract 391 (1933).]
AUTHORS.

5082. Astatic Magnetometer. E. Thellier. *Comptes Rendus*, 197. *pp*. 232–234, *July* 17, 1933.—The author remarks that owing to the difficulty with varying magnetic fields during the daytime in large towns, magnetometers are seldom used. The paper describes a double astatic system similar to that used in the Broca galvanometer. Three magnets are mounted on a vertical glass suspension, the middle magnet having a moment twice that of the upper and lower ones which are 35 cm. apart. The bottom of the glass support dips into a vessel containing oil, and the whole is enclosed in a vertical tube, with a window opposite the concave mirror carried on the suspension. Two small coils are used for the production of a weak field of about 0·02 gauss for orienting the system.
F. S. B.

5083. Electromagnetic Balance. D. S. Ainslie. *Rev. Sci. Instruments*, 4. *pp*. 546–548, *Oct*., 1933.

5084. Measurement of Very Small Inductances. Cecil L. Fortescue. *Journ. Sci. Instruments*, 10. *pp*. 301–305, *Oct*., 1933.—This article describes a method of measuring inductances of 0·1 microhenry with an inaccuracy not exceeding ½%, in spite of the presence of resistances as high as 4 or 5 ohms. A substitution method is employed, the comparison being against a standard variable inductance consisting of a wire and coaxial screening tube with sliding contacts. No unknown terminal inductances are involved and simple capacity measurements enable corrections to be made with the necessary accuracy when a suitable frequency is chosen. In the experiments described the frequency was 25 megacycles, the capacity corrections amounted to less than 7%, and were determined to within 5%, and the actual value of the inductance in one of the cases for which the method was developed, was found to be 0·0958 microhenry. AUTHOR.

See also Abstracts 4962, 5000, 5034.

MEDICAL RADIOLOGY AND ELECTROLOGY.

5085. Measurement of Heat Production in Diathermy. A. Hemingway and J. F. McClendon. *Physics*, 4. *pp.* 351–353, *Oct.*, 1933.—Resistance and reactance of diathermy patients to alternating currents of varying frequencies up to and including radio-frequencies have been measured with a h.f. Wheatstone bridge. At frequencies greater than $10^6\sim$ the resistance becomes constant and the reactance and phase angle decrease to zero. Under these conditions the human body behaves as a pure resistance and the heat production in calories can be computed from the formula $0 \cdot 24\ VIt$, where V is the r.m.s. voltage, I the r.m.s. current and t the duration time in seconds of the diathermy treatment. H.f. resistances of various parts of the body which are usually treated with diathermy are given. AUTHORS.

5086. X-Ray Shutter with a Simple Timing Device. W. Binks. *Brit. J. of Radiology*, 6. *pp.* 557–559, *Sept.*, 1933.—In precision X-ray intensity measurements it is often necessary to know with some accuracy the exposure time. To avoid errors due to sudden switching on of the h.t. generator, a lead shutter in the path of the beam may be used. The form of apparatus described has a combination of stop-watch and an electromagnetic relay. The closing of a switch starts the watch and opens the lead shutter; the second closing of the switch stops the watch and closes the shutter. Errors are reduced to about ½% in a time of 60 sec. J. E. R.

5087. Experimental Realisation of the Röntgen. G. W. C. Kaye and W. Binks. *Brit. J. of Radiology*, 6. *pp.* 530–556, *Sept.*, 1933.—An account is given of the X-ray standardisation equipment at the National Physical Laboratory for the realisation of the röntgen—the unit of quantity of X-rays. The apparatus consists of a graphite parallel plate ionisation chamber of the " free air " type, which is adopted as a primary standard. A considerable amount of theoretical and experimental work has been done on the most suitable form of diaphragm arrangement for these experiments. Two methods of estimating the volume of air ionised are investigated: (1) The cone method in which the cross sections of the beam at the two ends of the collecting electrode are measured photographically and the volume calculated directly. (2) The volume is calculated from the cylinder formed by the chamber diaphragm and the length of the collecting electrode, the intensity being measured at the chamber diaphragm. The results from the two methods are reasonably concordant. By reason of the non-uniformity of the focal spot or of the presence of extraneous off-focus radiation, it is established that the inverse square law of intensity of radiation is not exactly obeyed. Under suitable conditions the accuracy with which the röntgen can be realised practically by the present N.P.L. equipment is of the order of 0·5%. J. E. R.

5088. Retention of Radon in the Human Body. Maria R. Deinlein. *Akad. Wiss. Wien, Ber.* 142. 2*a*. 3–4. *pp.* 127–134, 1933.—The paper describes measurements of the time during which radon remains in the body after being taken in the form of a drink. The effect of taking

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food before and after drinking radioactive water and the influence of an alkali and acid stomach content were investigated and conclusions as to the most favourable time for drinking radioactive water are drawn.
W. E. P.

See also Abstracts 4953, 4956, 4957, 4958.

OSCILLATIONS.

See Abstracts 4793, 5012.

PHOTOELECTRICITY.

5089. Blocking-Layer Photoelectric Effect and the Einstein Relationship. F. v. Kôrösy and P. Selényi. *Phys. Zeits.* 34. *pp.* 716–718, *Sept.* 15, 1933.—Reasons are given for the dependence of the form of the curve of e.m.f. on open circuit against intensity of illumination upon the wave-length of the light used. Experiments make it very probable that this effect does indeed exist in the case of cuprous oxide cells. In order to ensure reproducibility the times of illumination used are only about 1/50 sec., the electrical measurements being ballistic.
L. A. W.

5090. Photoelectric Effect in Monocrystals of Cu_2O. R. Deaglio. *Accad. Sci. Torino, Atti,* 68. 4–10. *pp.* 513–524, 1933.—Experiments on the crystal photoelectric effect discovered by Dember [see Abstracts 1370 and 2993 (1932)]. These lead to the conclusion that the effect is not electronic, but is due to the illuminated cuprite acting as a conductor of the second class, and is of an electrolytic nature. A. D.

5091. Photoelectric Effect for Single Crystals of Cuprite. G. Mönch and R. Stühler. *Zeits. f. Physik,* 85. 1–2. *pp.* 131–134, *Aug.* 29, 1933.—Data are submitted on the time dependence of the crystal photoelectric effect given by single cuprite crystals from Chessy and from Cornwall. It appears that decay of the effect with time is observed only with the Chessy crystals and for this and other reasons it is believed that Deaglio's conception [see Abstract 4283 (1933)] of an induced electrolytic conduction is not in general applicable to the crystal photoelectric effect. [See also preceding Abstract.] W. S. S.

5092. Conduction of the Second Type in a Gas-filled Photoelectric Cell. L. Dunoyer and P. Paounoff. *Rev. d'Optique,* 12. *pp.* 241–264, *June–July,* 1933.—The behaviour of a gas-filled photoelectric cell with a hemispherical kathode, plane window and wire anode is examined at high voltages. The current-voltage curve is continuous, but the mode of conduction that it represents becomes established only after a period of preparation. Further, it disappears after a sufficiently long period of operation and if the potential is applied suddenly to the cell after the latter has been suitably prepared, the conduction is first of the " normal " type and then of the high-voltage type (immediately before disruptive discharge sets in if the potential is high enough), each type of conduction lasting for a few hundredths of a second. If the variations in the light-flux are sufficiently rapid, the current of the second type conduction is almost proportional to the incident flux. It is concluded that the second type conduction is due to the emission of secondary electrons from the kathode under the influence of positive ion bombardment, the magnitude of the latter being dependent upon the field strength and the geometrical properties of the cell. F. C. C.

See also Abstract 4846.

PIEZOELECTRICITY.

See Abstract 4793.

THERMIONICS.

5093. Evaporation of Atoms, Ions and Electrons from Caesium Films on Tungsten. J. B. Taylor and I. Langmuir. *Phys. Rev.* **44.** *pp.* **423–458,** *Sept.* **15, 1933.**—Precision methods for measuring the number of Cs atoms adsorbed on tungsten are described. With these methods for determining Θ (the fraction of the surface covered with Cs), the rates of atom, ion and electron emission are measured as functions of Θ and T, the filament temperature. The rate of atom evaporation increases rapidly with Θ and with T. At low filament temperatures and high pressures of Cs vapour the concentration of adsorbed Cs atoms approaches a limit $3{\cdot}563 \times 10^{14}$ atoms/cm². of true filament surface (one Cs atom for four tungsten atoms). This film ($\Theta = 1$) exhibits all the characteristics of a monatomic layer. The formation of a second layer begins only at filament temperatures corresponding to nearly saturated Cs vapour. A theory of the formation of polyatomic layers and experiments supporting it are described. Results are given for the heat of evaporation for Cs atoms from clean tungsten for different values of Θ. From the values obtained for electron (γ_e) and ion (γ_p) emission for zero field the contact potential is calculated and is found to agree, except for very concentrated films, with the value calculated entirely from data on neutral atom evaporation. Data are given for the electron emission at constant temperature and for the positive ion emission and work function. It is shown that the saturated ion current from a clean hot (1200°–1500° K.) tungsten filament is an accurate measure of the number of atoms striking the filament per second. The condensation coefficient for atoms striking a tungsten filament is proved to be unity from $\Theta = 0$ to nearly 1. This is discussed, together with surface migration, as regards the mechanism of evaporation and condensation in dilute and concentrated films. A " surface phase postulate " is advanced, according to which all the properties of the adsorbed film are uniquely determined by Θ and T. A. W.

See also Abstract 5019.

THERMOELECTRICITY.

5094. Thermal Wattmeter. B. A. Sharpe. *Journ. Sci. Instruments,* 10. *pp.* 318–321, *Oct.,* 1933.—The paper contains a description of a sensitive thermal wattmeter for h.f. measurements and shows how inaccuracies due to imperfect matching of commercial components can be corrected. AUTHOR.

See also Abstract 5018.